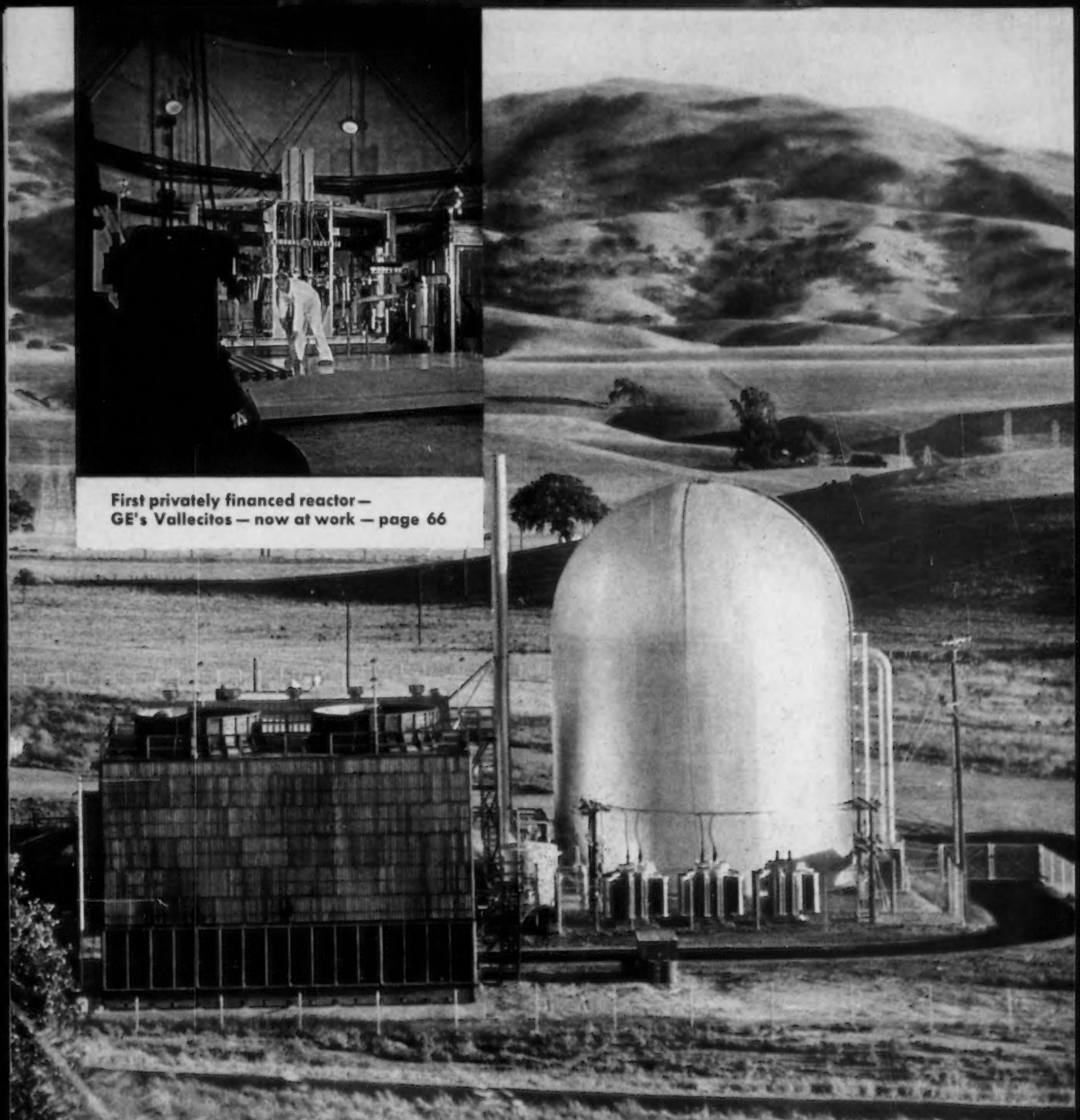


First privately financed reactor—
GE's Vallecitos—now at work—page 66

APRIL 14, 1958 PRICE 50 CENTS

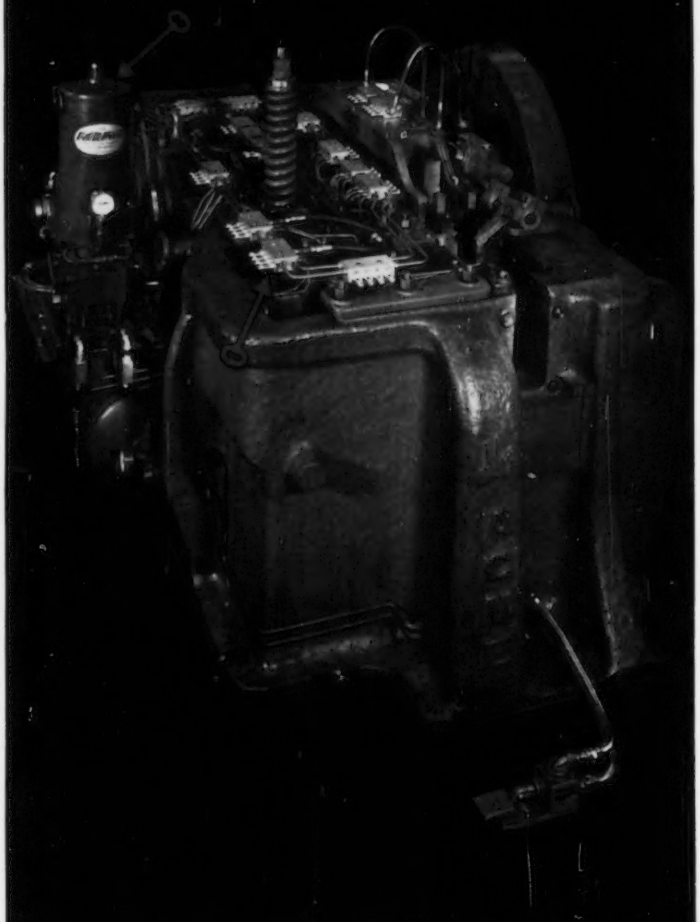
Product Engineering

DESIGN edition

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT

FARVAL—*Studies in Centralized Lubrication*
No. 218

Farval lubrication first choice for Hill-Acme Upsetter



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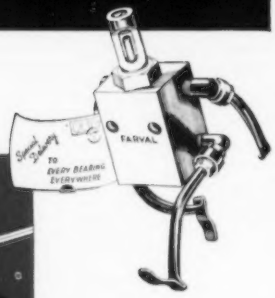

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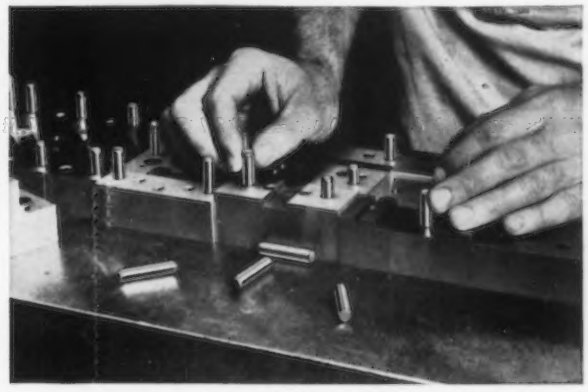

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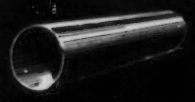

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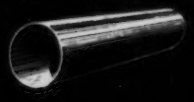

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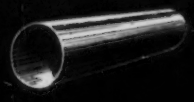

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

APRIL 14, 1958 Vol. 29, No. 15

STAFF REPORT

Atomic Energy: The Facts 52... Annesta R. Gardner, Associate Editor
We've come a long way since Hiroshima; but nowhere as far as we'd like to believe. Here's where we stand, and how we can step up future progress.

Spring Clutches for Faster Response 57... Eugene V. Leonard, Digitronics Corp.
Essence of the idea is a helical spring bridging input and output shafts. Article describes applications; works out an example showing advantages of spring clutch for high-speed indexing.

Semiconductors—Revolution at Hand 60... A Staff Report
Besides transistors, there are now thermistors, solar cells, luminescent panels . . . and solid-state physicists see a growing number of fascinating, important applications ahead.

Design Features in New Products 64... Folding jeep carries four passengers; immersed motor stays dry; work tilts against tool; portable movie projector threads itself; gears compute winding data for basket coil.

Molded Silicone Rubber Parts * 69... D. P. Spalding, General Electric Co.
They take abuse at high temperatures but may be weaklings during installation. Here are tips on curing, shape of part, and other variables that determine satisfactory service.

Fresh Look at Leaded Steels 72... W. Simon, Westinghouse Electric Corp.
Thanks to improved techniques, adding lead now gives steels with good machinability—and less worry about loss of tensile, impact, and fatigue strengths. Here are helpful design data.

Air Valves—the K-Factor * 74... Boyde Dahle and Clint Miller, Parker Aircraft Co.
Reliable technique is updated to estimate pressure losses in a pneumatic system, component by component. With charts for actual valves and fittings; nomogram for fast answers.

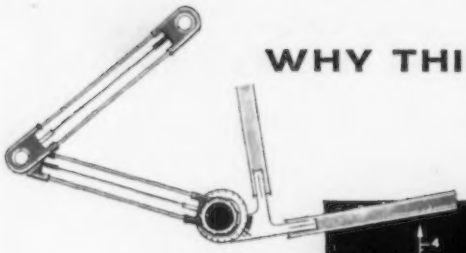
DESIGN FILE

12 Ways to Retain Electron Tubes 82... F. W. Wood, Jr., Servonics, Inc.
Survey of practical ways to hold the tubes in sockets.

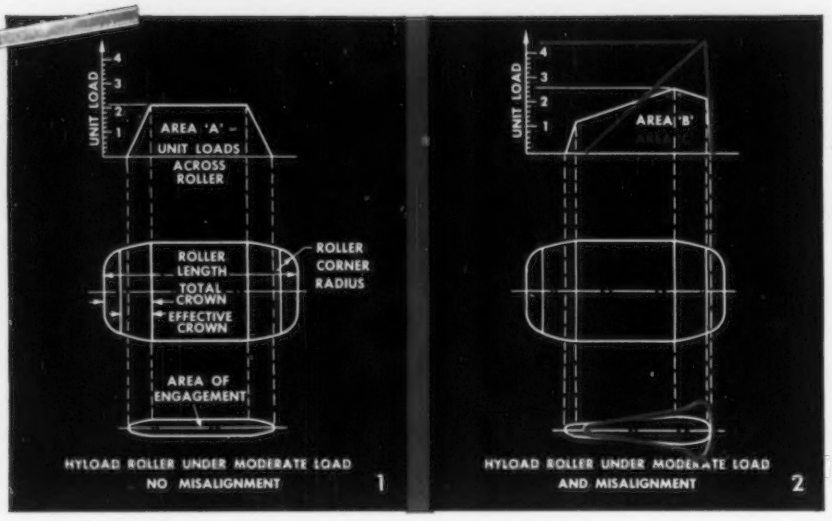
Shrink-fit Nomograph 85... Sigmund Rappaport, Ford Instrument Co.
For steel and cast-iron rings of equal length.

DEPARTMENTS

Interesting to Note	5	New Components, Materials	89
Developments to Watch	19	Catalogs and Bulletins	129
The Engineering Week	21	Design Abstracts	138
Reader to Editor	26	New Books	141
Design Perspectives	47	* Current Reprints	147
Editorial	51		



WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS



HY-LOAD ROLLER CROWNING MINIMIZES EFFECTS OF MISALIGNMENT—LENGTHENS BEARING LIFE

In any roller bearing, the design and quality of the rollers themselves vitally affect the performance of the entire bearing. The distribution of the load across the roller's full area of contact must be carefully controlled. End-loading and conditions of misalignment can seriously reduce the life of a roller bearing. How HYATT minimizes these effects is detailed at the right.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N.J., Pittsburgh, Detroit, Chicago and Oakland, California

The unit load on any roller is distributed axially in a uniform manner except at the ends where crowning has been provided. Figure 1 shows how the unit load drops off to zero at the ends of the area of contact. The summation of unit loads represented by area "A" is the total roller load. This same load under conditions of misalignment (Figure 2) must result in an area "B" equal to area "A"; but the maximum unit load is considerably greater and the misaligned bearing will therefore have a shorter life. However, if the same total load is applied to an uncrowned roller in a misaligned bearing, as shown in red, a much higher maximum unit load (area "C") results, and would reduce the life of the bearing. This demonstrates why HYATT Hy-Load Series Bearings with roller crowning run smoother and longer even under conditions of misalignment.

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Interesting to Note . . .

A Letter Started It

It was only 19 years ago that a communication from two German refugees appeared in the "Letters to the Editor" column of a British magazine, casually announcing one of mankind's greatest scientific feats—atomic fission. In the Feb. 11, 1939, issue of *Nature*, there appeared a letter entitled, "Disintegration of Uranium by Neutrons: a new type of Nuclear Reaction." Written by Lise Meitner and O. R. Frisch, it ". . . discussed the development and implications of the finding of barium as a product of the neutron bombardment of uranium." This opened the gates; within a year more than 100 papers were published confirming the report by Meitner and Frisch as well as adding more knowledge to the new-born science of nucleonics.

It has taken time—and will take even more to make full use of this science but, in a grain field at Vallecitos, Calif., American industry's first privately financed reactor is now at work. It's a "boiling water" design, built to provide operational data for the full-scale Dresden reactor under construction by GE for Commonwealth Edison of Chicago. The article on page 52 describes these achievments as well as R & D opportunities in and with atomic power. As for our cover, it shows an exterior view of the Vallecitos reactor and an interior shot—loading the reactor core.

Electronics Marches On

The other day we were amused to see "a new electronic marvel" advertised in the window of a local hobby shop—a do-it-yourself miniature radio that has no wires, no tubes and *no transistors*. Curiosity got the better of us and we asked to see this "miracle radio." Electronics marches on, transistors find their way into more and more new products. Yet here was a crystal set—it was an eye opener to find the old "cat's whisker" and tiny crystal still with us.

History of the transistor actually goes back to 1833 when Michael Faraday found that silver sulfide had a negative temperature coefficient of resistance. This characteristic set it apart from other metal conductors whose resistance increased with a rise in temperature. A host of scientists added further knowledge and shortly after the second World War, Bell Telephone Laboratories established a semiconductor group made up of chemists, physicists and metallurgists. Though Shockley and Bardeen were influential, no one in-

(Continued on page 7)

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A McGRAW-HILL PUBLICATION

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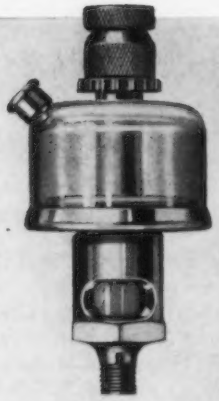

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Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

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GEAR CASE GAUGES

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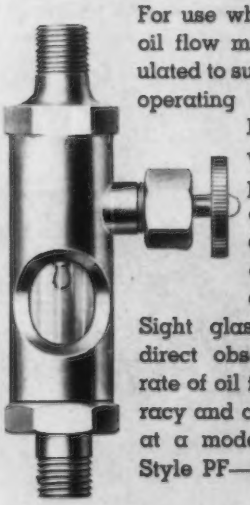

For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

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dividual can be credited with invention of the transistor.

According to Dr. Guy Suits, vice-president and director of research at General Electric, "semiconductors (in the form of transistors), which were nonexistent in 1950, grossed $140 million in 1957 and are projected to reach the billion-a-year figure by 1967." On page 60 appears an article presenting a rundown of current uses for semiconductors ,as well as applications we'll be seeing next.

Vacuum Tubes Were His Specialty

Every scientist's dream is to be invited to the biggest laboratory in the country and allowed to wander about, working on whatever project seems of interest. This dream very rarely materializes, but in 1909 it did, for 29-year-old Irving Langmuir. General Electric's industrial laboratory director, the late Willis R. Whitney (photo, right), gave Langmuir (left) a free run of the labs. Langmuir watched scientists working with light bulbs and X-ray tubes; with vacuum pumps and rain-making machines.

Finally, the young man decided on a project—find out why some tungsten filaments fail within a vacuum tube. He had just completed his doctorate on gases and felt

qualified to spend time experimenting with one of his theories—to prove that a perfect vacuum tube didn't mean a brighter lamp. As a result of three year's work he designed a bulb with a light intensity never before achieved. Langmuir later worked with vacuum tubes, and greatly improved the life of De Forest audions (PE —Mar. '57, p. 5). Our present electron tubes (see page 82) will live longer because of Langmuir's groundwork.

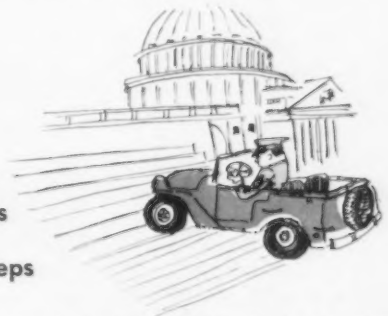
One of his most fruitful results with tube research was purely by accident. When testing tungsten for its electron-emitting qualities, he accidentally picked up a tube that had been used by Dr. W. D. Coolidge, GE's X-ray expert. He found the particular filament within the tube produced electrons in a tremendous quantity. Upon checking, he found that Coolidge had coated a tungsten filament with a layer of thoria. This led Irving Langmuir to produce even better tubes.

Get the Lead Out

How much lead goes into your lead pencil? Absolutely none. Why the pencil was misnamed "lead pencil" is not known, but we do know that it dates back to 1565. This was just 11 years after discovery of the famed graphite mine in Borrowdale, Eng. Local shepherds had come across this hill of graphite and found the soft black material suitable for branding sheep. Pencils followed. Before long, the hill was impounded by the Crown and the exportation of graphite became a crime.

In 1795, the French government was suffering from the embargo. Napoleon commissioned Nicholas Conte, a mechanical engineer serving as a surgeon in his army, to find a way to use France's impure version of graphite in a pencil. Conte found it. He mixed graphite powder with clay, fired it like a piece of pottery, and came up with a hard "lead" similar to that in pencils today. This "lead" solved another problem. Previously, the soft graphite was easily smudged. With hardening clay, it became durable.

Today, America's 15 pencil manufacturers produce about 1.5 billion lead pencils annually—and none contain lead. Actually our pencil is also misnamed. The word is from the Latin *penicellum*, meaning "a little tail" because the first pencil was made from a pig's bristle. On page 72 appears an article entitled "Leaded Steel." Don't mistrust the word here—it does contain lead.



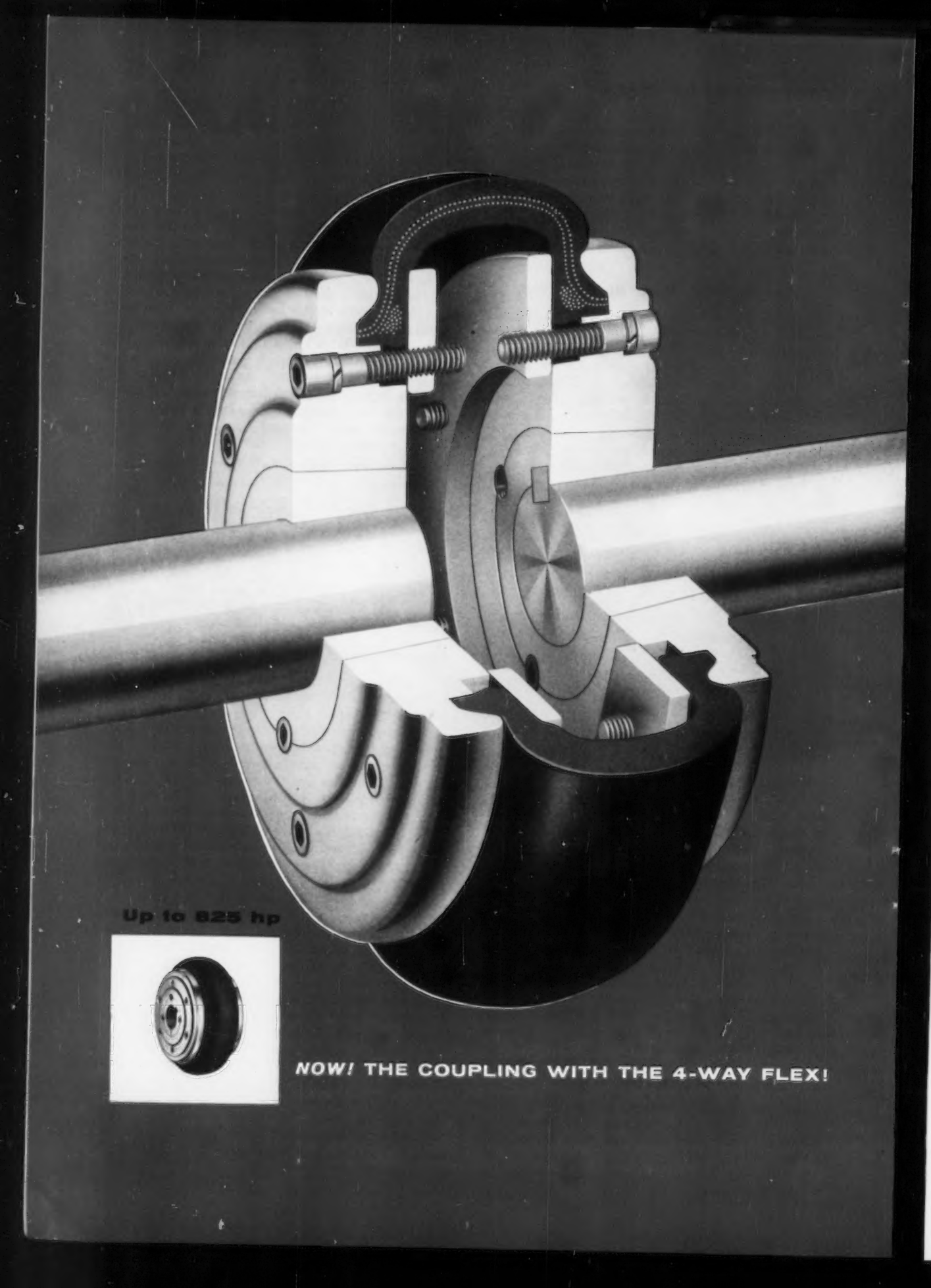
Good Things Come in Jeeps

During the worry days of World War II, the situation in Europe was touch and go. Opposing forces were separated from each other by hedge rows; enemy scouts infiltrating through anti-Axis lines were a constant danger. One moonless night, a French sentry was standing his post. From the darkness he heard a group of foot soldiers approaching. As trained, he issued the customary challenge, "Who goes there?" One of the shadows replied, "We are Americans." Without hesitation, the sentry raised his submachine gun and annihilated a small German patrol. When asked later how he knew the soldiers were German, the Frenchman proudly replied, "That's easy—Americans, *they* come in jeeps."

The jeep, a symbol of the second World War, was used for myriad purposes—fighting fires and snow, hauling penicillin and planes, carrying wounded, and even by some chaplains as an altar. A current application of the jeep is pictured on page 64—a vehicle with folding aluminum body that can be parachuted from a plane.

Although "jeep" first appeared as a small mythical animal in the late E. C. Segar's cartoon strip, "Popeye," it later became a contraction of "Army truck ¼ ton, 4 x 4, G. P. (General Purpose)." In 1941, Willys' test-driver Red Hausmann coined the word formally after he had taken Washington correspondent Katherine Hillyer up and down the steps of the Capitol. When asked what he called the car, Hausmann replied with paternal pride, "It's a Jeep."

—Benedict A. Leerburger Jr.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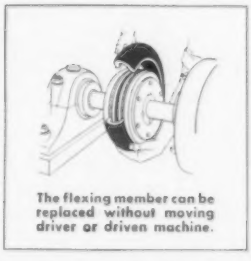
The technological advances that contribute to the miracle of today's truck tires, which are engineered to carry tremendous loads at high speeds and stand terrific shock, have made this new type of coupling possible.

The heart of Para-flex is a tire with synthetic tension members bonded together in rubber. It is pliant. It "fits itself" to changing shaft conditions—angular, parallel, end-float, *or any combination of all three!* Depending upon the size of coupling and duration of shaft misplacement, it handles angular misalignment up to 4°, parallel up to ⅛" and end-float up to 5/16".

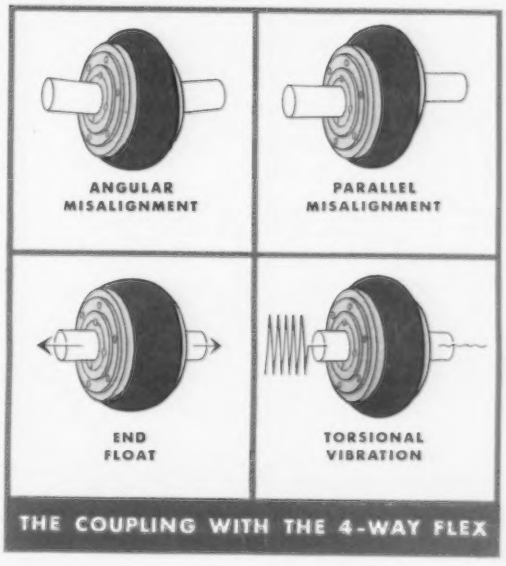
It cushions the stresses of shock loads to a remarkable degree. And it tends to absorb torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

There is no metal-to-metal contact between shafts. They are insulated. No lubrication is required.

Para-flex takes a minimum of space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine!*



The flexing member can be replaced without moving driver or driven machine.



THE COUPLING WITH THE 4-WAY FLEX

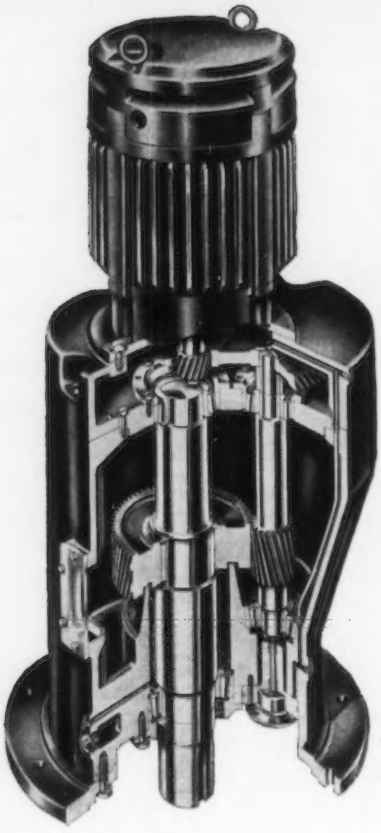
Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 825 hp at 1200 rpm. Call your distributor for early delivery to *make your own test.* You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 1200 Union Street, Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods in the mechanical transmission of power. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer." Or write us.



new for vertical applications

Compact In-line Motoreducer—Here's real design flexibility. And here's simplification of your drive problems—plus substantial savings in space. The new Philadelphia Vertical Motoreducer offers *straight-through* shaft arrangement, with motor and reducer vertically in line. Result: tremendous adaptability where horizontal motor arrangements or right angle drives are difficult to install. Capacity up to 400 hp with ratios to 86.5:1

Designed to give you quality construction in an inexpensive reducer assembly. Just look at the features . . .

Strength. Rugged cast iron frame. Heavy duty bearing support for superior gear performance and longer gear life. Heavy duty output shafting takes most severe overhung load conditions.

Convenience. All standard motor enclosures available. Multi-speed motors or variable-speed drives can be supplied to provide economical in-motion speed control.

Easy maintenance. First reduction pinion and gear easily accessible for quick replacement. Changes in unit output speed quickly made with stock helical gear sets.

Trouble-free service. Rugged crown-shaved helical gearing assures long, efficient service life. Two-way seals seal out dirt and atmospheric contaminants. Unique Philadelphia dry well construction positively prevents oil leakage down output shaft.

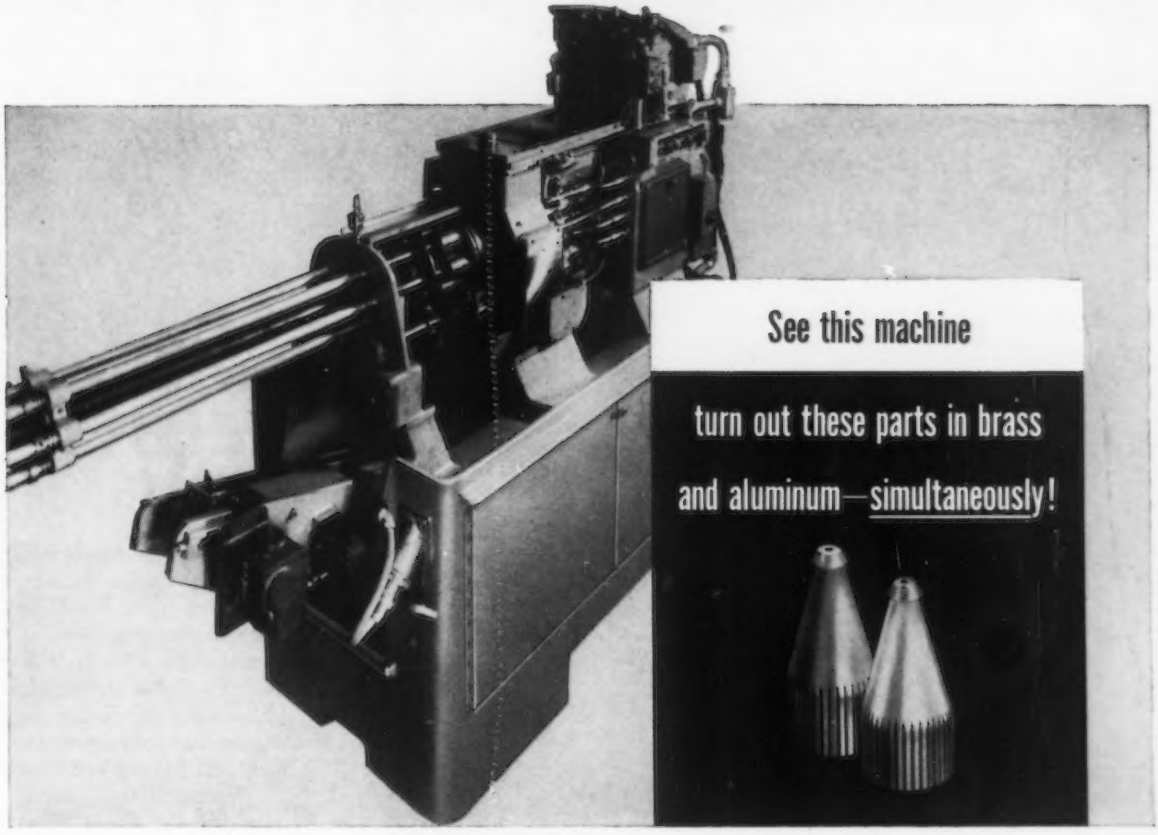
Get full details—no obligation. Write for our new Catalog A-27 or call your nearest Phillie Gear Office. Philadelphia Gear Works, Erie Ave. and G Street, Philadelphia 34, Pa.

Offices in Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

phillie gear®

BETTER MACHINING STARTS WITH ALCOA SCREW MACHINE STOCK

Alcoa proved it in Cleveland . . . now will prove it in other cities



See screw machine parts produced in aluminum at less cost than steel or brass

When Alcoa and National Acme Company sponsored a machining demonstration in Cleveland last September, 700 design and production engineers and purchasing people saw aluminum and brass parts produced *simultaneously* on a six-spindle automatic screw machine—saw documented evidence that screw machine parts can be produced cheaper in aluminum than in brass or steel. Many expressed frank amazement at the cost comparisons shown.

Here is eye-opening machining news for all industry. Now *you* can see this demonstration, which Alcoa will sponsor in Chicago, Boston, New York*, Detroit, Los Angeles and other important centers.

If your function is design or production of products that use screw machine parts, you will find the Alcoa machining demonstration an enlightening experience. You will see how aluminum offers the ultimate in design freedom because it's so workable, so easy to machine—because it gives better finishes including anodized color. You will see the new color movie about Alcoa Screw Machine Stock, "The Four Amazing Alloys."

Send in the coupon for your invitation—and for a Design Calculator (slip-stick) for use with Alcoa® Aluminum Screw Machine Stock.

WE CHOOSE ALCOA ALUMINUM SCREW MACHINE STOCK

"ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

*May 7, 8—Alcoa's Bridgeport Works
Atlantic Street, Bridgeport, Connecticut

Aluminum Company of America
865-D Alcoa Building, Pittsburgh 19, Pennsylvania

Yes, I want to attend the Alcoa machining demonstration nearest my area_____.

Please send my invitation—and Design Calculator.

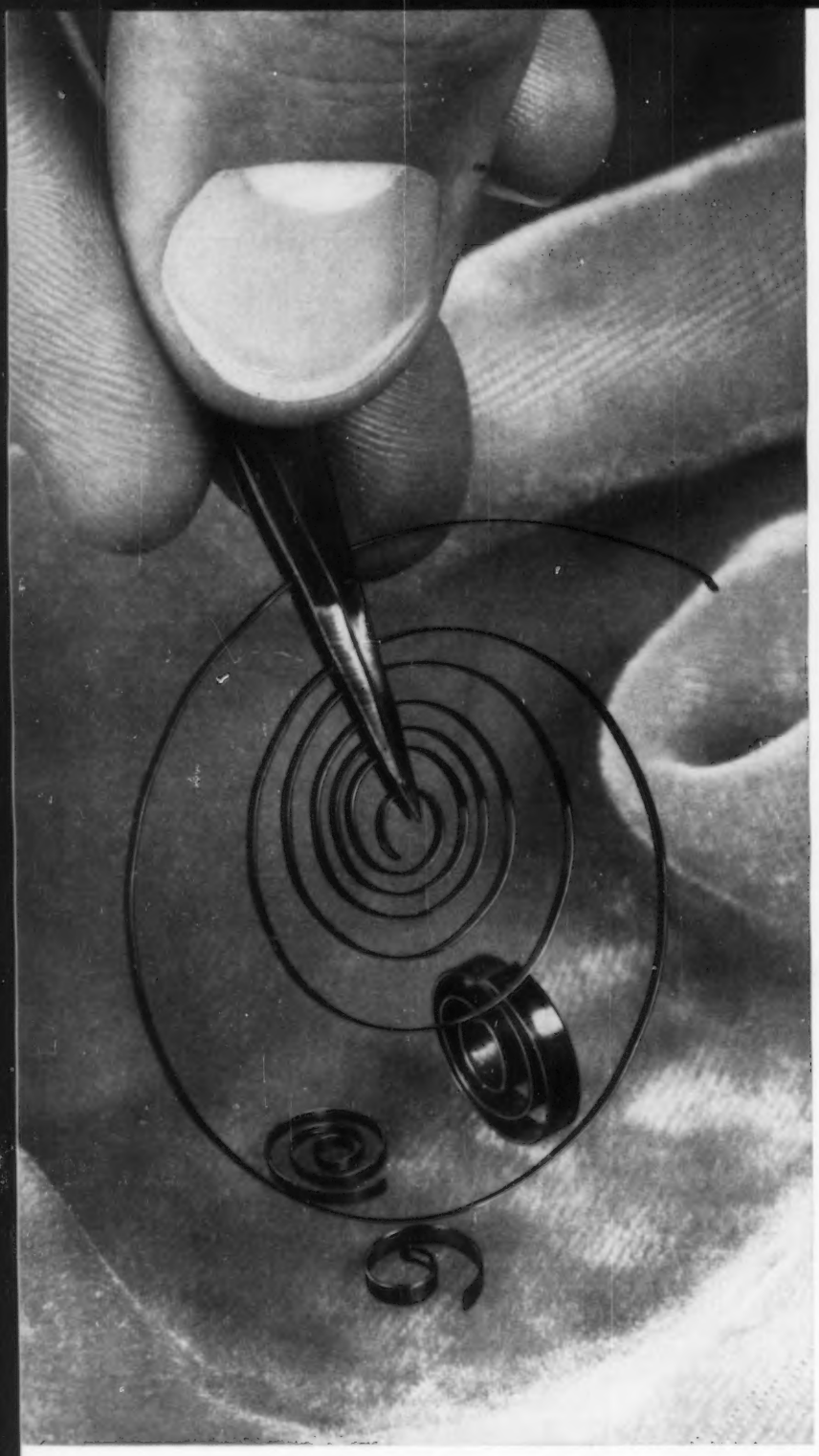
Name_____

Position_____

Company_____

Address_____

City_____ Zone____ State_____



For spring life everlasting...

NILCOR* ALLOY!

Nilcor alloy is not a steel! It is truly unique. It is believed to have no equal, for example, for continuous life in miniature springs. Further, it is non-magnetic and far outdistances steel or any known alloy in resistance to "set", fatigue and corrosion . . . even at high temperatures.

Major use to date is for non-breakable power springs in fine watches. But more and more Nilcor alloy is and will be furnished for the most critical requirements in instrumentation, control devices and equipment of many types . . . wherever extreme spring life and precise behavior are vital.

Perhaps National-Standard Nilcor alloy holds promise for some of your needs. We shall certainly be glad to cooperate *all* the way in helping you find out. Just check with our Athenia Steel Div., Clifton, New Jersey.

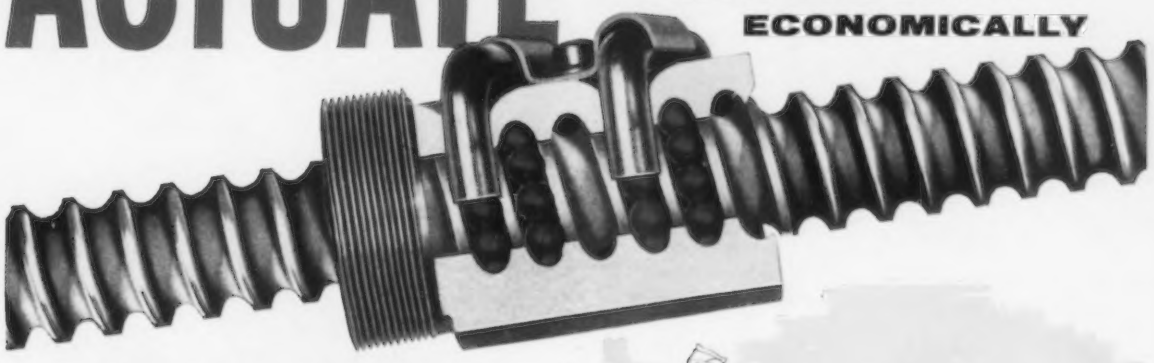
*Trade Mark National-Standard Co.

NATIONAL NS NATIONAL STANDARD Company **STANDARD**

DIVISIONS: NATIONAL - STANDARD, Niles, Mich.; *fine wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

ACTUATE

MORE QUICKLY . . .
EFFICIENTLY . . .
ECONOMICALLY



ROLLED THREAD

SAGINAW b/b SCREWS

Give Volume Products New Production and Sales Advantages

Because Saginaw employs an important anti-friction principle—steel balls recirculating in closed-circuit raceways—b/b Screws provide efficiencies of over 90%—perform up to *5 times* better than acme screws. Saginaw b/b Screws require far less torque—save up to 85% on operating power or manual effort. They are smaller and lighter than comparable units—permit smaller motors and gear boxes; often eliminate clumsy auxiliary parts. May be used with flange, trunnion, worm wheel or torque tube adaptors. Smooth, almost frictionless operation assures long, trouble-free performance, even in extreme temperatures and with lack of lubrication.

"OFF-THE-SHELF" STOCK REDUCES COST

Saginaw b/b Screws are the only kind stocked in seven commercial rolled thread sizes, in 6-inch increments of length (up to 4 ft. for .375" BCD, 8 ft. for .631" BCD, and 11 ft. for all larger sizes.) Ball Circle Diameters are as follows:

.375" .631" 1.000" 1.171" 1.500" 2.250" 3.000"

MANY TYPICAL APPLICATIONS

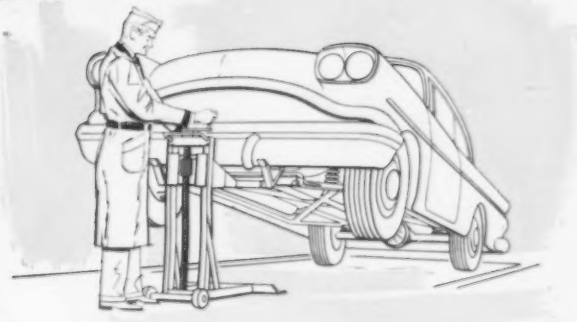
Saginaw b/b Screw standard assemblies have been successfully applied to such products as bumper jacks, automatic garage doors, automobile seat adjusters and window lifts, beauty parlor chairs, hospital beds, and circuit breakers. They are also being used in heavy industrial equipment like die table positioners, drill presses, lift trucks and welding machines.

FREE ENGINEERING HELP FOR YOUR SPECIAL APPLICATION

Let Saginaw's experienced engineers help you solve your special application problems. Just write or phone us your requirements, or fill in and mail the handy coupon below.

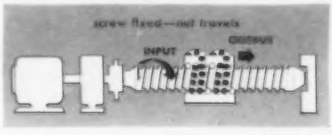
Saginaw
ROLLED THREAD ball bearing Screw

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.



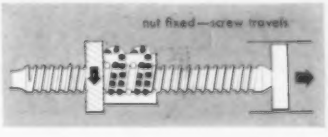
With a Saginaw b/b Rolled Thread Screw in the jack, just a spin of the handle raises a heavy car easily . . . smoothly . . . safely.

HOW THE WORLD'S MOST EFFICIENT ROTO-LINEAR DEVICE WORKS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque.

SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with new efficiency.



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or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
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Please send new engineering data book on Saginaw b/b Screws and Splines to:

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It's your move ... BUT PLAY SAFE!

SELECT GARLOCK MOLDED AND EXTRUDED RUBBER PARTS FOR ASSURED QUALITY

You can be sure of consistent high quality when you specify Garlock molded and extruded rubber parts. Why? Because Garlock has broad experience in compounding natural and all synthetic rubbers including silicone. Whether your problem involves temperature extremes, difficult liquids or gases, compression set, abrasion, or tear resistance—Garlock engineers can recommend a material and design best suited for the job. Moreover, Garlock manufacturing facilities are available for large quantity production of molded and extruded parts.

Molded and Extruded Rubber Products are another important part of "the Garlock 2,000" . . . two thousand different styles of Packings, Gaskets, and Seals for every need. The only *complete* line. That's why you get unbiased recommendations from your Garlock representative. Call him today, or write us about your needs.

THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For prompt service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Which Type ADJUSTABLE SPEED DRIVE CONTROL Do You Need? SQUARE D BUILDS BOTH!

Typical application of Adjustable Voltage Drive to large metal spinning lathe in operation at Phoenix Products Company, Milwaukee

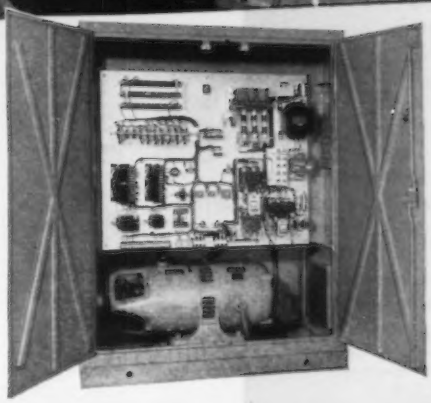
ADJUSTABLE VOLTAGE CONTROL FOR M-G SETS...Through 400 HP

Simplified Circuits with rugged heavy-duty control components.

Easy Maintenance because standard magnetic starters, relays and timers are used in combination with static regulators.

3 Types Available • (*1*) magnetic amplifier exciters (*2*) dry disc exciters (*3*) rotating exciters.

Easy to Adjust because centralized "tune-up" elements are accessible and readily identified.



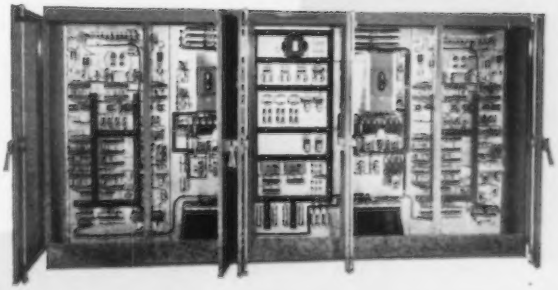
FULLY ELECTRONIC with SIMPLIFIED FAIL-SAFE CIRCUITS THROUGHOUT

Simplified Circuits use less tubes. Fail-safe circuits prevent motor runaways.

Easy Maintenance because sub-panels can be quickly removed and replaced. "Brain" panel senses varying conditions.

Easy to Adjust with only a few, very accessible potentiometers.

Both types are available in two kinds of construction—standard package and custom-built.



Write for descriptive literature. Address Square D Company, 4041 North Richards St., Milwaukee 12, Wis.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

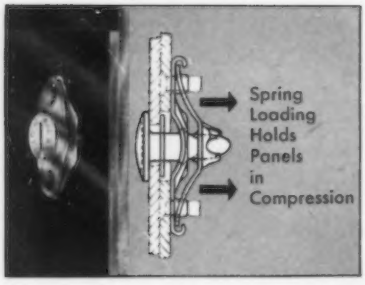
SQUARE D COMPANY

Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

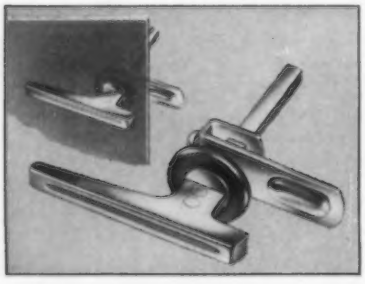
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



Quarter-Turn Fastener

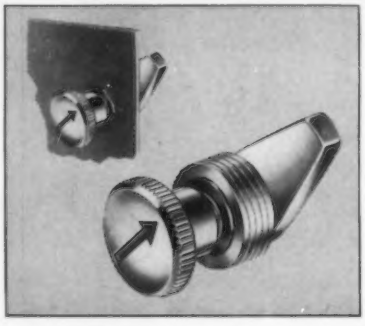
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

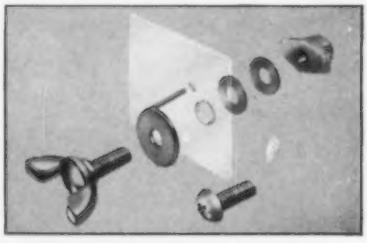


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.

Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other special fasteners. Fifty-two pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

LION

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* *Quotation from 'Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.*

DU PONT

Better Things for Better Living ... through Chemistry

PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON ZYTEL® nylon resins

Jacketing of Du Pont ZYTEL® nylon resin protects wiring against wear, heat, stress

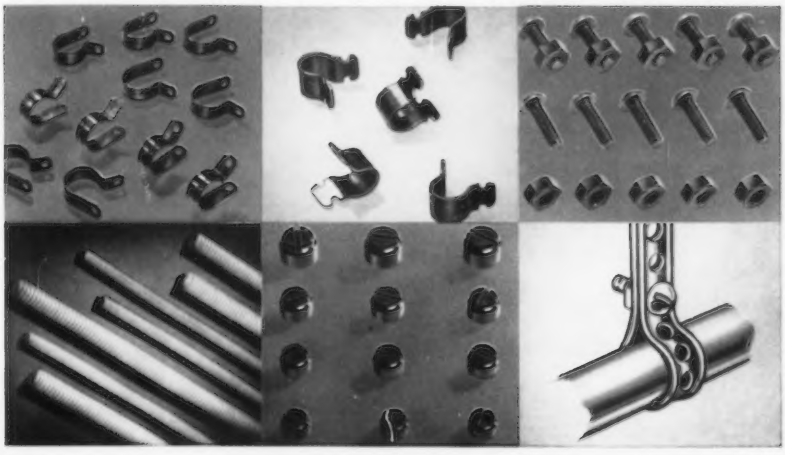
Most of the wiring in the Martin MATADOR is covered with Du Pont ZYTEL nylon resin. ZYTEL is tough, providing excellent protection for primary insulation. The material has very high tensile strength and outstanding abrasion resistance. Wire made with ZYTEL is rated for use in the MATADOR from −67°F. to +221°F. Wiring protected by ZYTEL is employed in the guidance and control system of the missile, on the jet engine, and in the stabilizer controls.

The coating of ZYTEL permits safe handling of wire during production and assembly. Cuts are prevented when grouping wires on harness boards or dressing them into the missile. Wires covered with ZYTEL withstand pulling through holes and are not damaged by clamping.

Problems due to difficult operating conditions can frequently be solved with the aid of Du Pont ZYTEL nylon resin. Learn more about wire protected with ZYTEL for use in your own designs. Request information by sending the coupon on the next page.

GROUPS OF WIRES protected by ZYTEL nylon resin terminate in components of the guidance system of the MATADOR guided missile. The wires withstand heat and cold, are insensitive to handling during production and assembly, can be pulled through openings without damage. (The USAF TM-61 MATADOR is manufactured by The Martin Company, Baltimore, Maryland.)

Rugged hardware made of ZYTEL® offers many design advantages



Shown here are cable clamps, clips, screws, threaded rods, nuts and perforated strapping—a few of the many hardware products being made of ZYTEL. These molded parts offer such advantages as light weight combined with great strength, good dielectric properties, excellent bearing characteristics. ZYTEL can be molded in colors to make designs more attractive . . . or for color coding. The material cannot rust and is unaffected by oils, grease or gasoline. (Parts illustrated are molded by the Weckesser Company, Chicago, Illinois.)

OVER

DU PONT

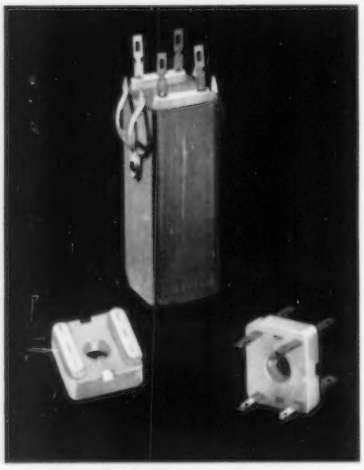
Better Things for Better Living ... through Chemistry

PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON ZYTEL® nylon resins

Strength, ease of assembly determine choice of ZYTEL® for electronic part

More than 200,000 of these I.F. transformer bases have been molded of ZYTEL over the past two years, with complete customer satisfaction. In addition to its excellent dielectric properties, ZYTEL is not brittle, does not chip or break at thin sections, and can be molded to uniformly close tolerances—in this case ± .003". The terminals are welded fast in their slots during assembly by the heat applied to them during soldering, providing a considerable advantage in production. ZYTEL withstands high cabinet temperatures, often encountered in electronic devices.



I. F. TRANSFORMER is mounted on a durable base of ZYTEL nylon resin, shown with and without inserted terminals. (Molded by W-L Molding Company, Kalamazoo, Michigan, for Sioux Radio Products, Yankton, South Dakota.)

Production cost of EDSEL carburetor part slashed 50% by use of ZYTEL® nylon resin

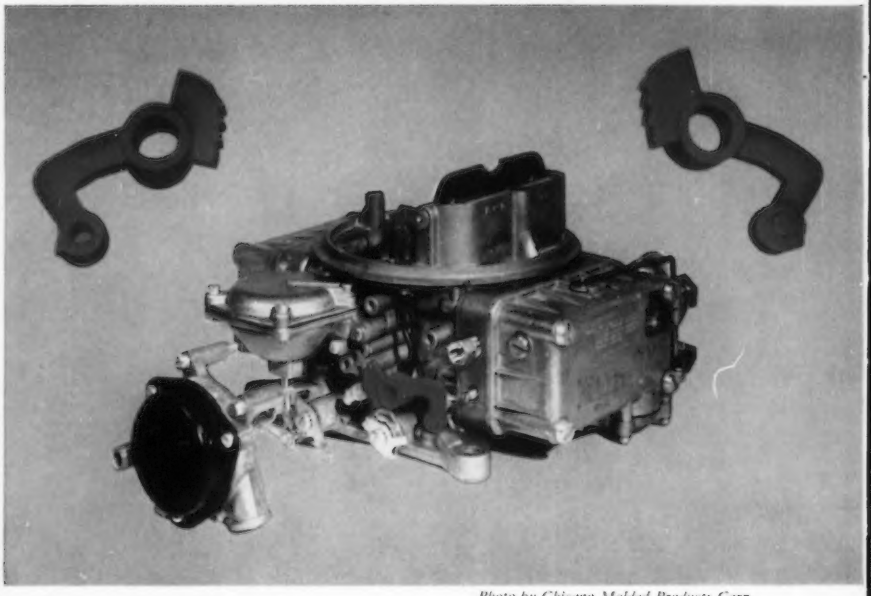


Photo by Chicago Molded Products Corp.

FAST IDLE CAM of the carburetor used on the new EDSEL automobile is made of ZYTEL nylon resin. The molded cam eliminates 3 finishing operations and saves over 50% in production costs as compared to metal. The cam automatically raises the idle setting when the engine is cold. (Part molded by Chicago Molded Products Corp., Chicago, Illinois, for Holley Carburetor Co., Van Dyke, Michigan.)

Use of ZYTEL nylon resin to make this carburetor cam speeds production, reduces costs, and results in a better part for the job. ZYTEL is ideal for this application because of its low frictional characteristics. Parts made of ZYTEL—such as gears, bearings, and cams—need little or no lubrication. ZYTEL is unaffected by engine compartment heat. Its high strength and exceptional resistance to abrasion provide long operating life.

The cam is injection molded by Chicago Molded Products Corp. in an eight-cavity mold. By using ZYTEL instead of metal, three finishing operations are eliminated and the cost of manufacturing the part is reduced by over 50%.

• • •

Similar advantages can be yours when you design with Du Pont ZYTEL nylon resins. Ask for the technical facts and examples of end-uses.

E. I. DU PONT DE NEMOURS & CO. (Inc.)
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Please send me more information on Du Pont ZYTEL nylon resins. I am interested in evaluating this material for:

NAME_____ POSITION_____

COMPANY_____ STREET_____

CITY_____ STATE_____ TYPE OF BUSINESS_____

SEND FOR INFORMATION

For additional property and application data on Du Pont ZYTEL nylon resins, mail this coupon.

DEVELOPMENTS TO WATCH...

All-nylon propellers . . .

. . . and nylon-coated compressor pistons, turbine rotors, and fans are attracting attention in Europe.

The propellers—for trawlers and other small boats—are made by Hundested Bruk A.S., Hundested, Denmark. Their advantages: light weight, resistance to fouling, and resistance to cavitation erosion.

The nylon-coated parts, made in Czechoslovakia, are also said to have good resistance to cavitation—as good, at least, as stainless steel. A hot-spray technique is used with a new spray gun said to produce unusually dense and non-porous coatings.

The gun, designed by the Czech Material Protection Research Institute in Prague, has a special nozzle, featuring concentric tubes. A mixture of air and resin powder is fed through the center; the next layer carries air alone, and the flame burns on the outside. This, the Czechs say, prevents the plastic from overheating and assures a good coat. One limitation: Almost any thermoplastic can be sprayed, but, in each case, it's necessary to heat the base metal to a temperature of about 50 F above the melting point of the plastic. On thin sheets, this might cause trouble, particularly with the lower-melting nonferrous metals.

New flameproofing compounds . . .

. . . for hydraulic fluids, plastics, textiles, paints, and paper are being developed by Michigan Chemical Corp. These are bromide-based compounds. Five are now available in sample quantities for test purposes. One of the new compounds, pentabromophenol, combines fungicidal activity with flame-retardance. Another, a bromopropyl phosphate, characterized by high density (specific gravity at room temperature is 2.25), seems especially promising for use in extreme-pressure lubricants and hydraulic fluids. Technical data on all five and on related compounds may be obtained from Industrial and Pharmaceutical Div., Michigan Chemical Corp., Saint Louis, Michigan.

Lead ferroelectrics, and porcelain enamels . . .

. . . of the low-firing type, are being developed for steel and aluminum under Lead Industries Association sponsorship. It's part of a continuing program aimed at developing new uses for lead. The ferroelectric and enamel programs are just getting under way (the former at the U. of California; the latter at the U. of Illinois). Reports will be issued by the association as work progresses.

As a portable power source . . .

. . . for heaters, industrial trucks, air conditioners, and even traveling refrigerators, "bottled" LP gas is attracting new attention. Even in established applications like soldering torches, it's taking on a new look, as the photo at the right shows. Advantages, in addition to portability, include operation over an extremely wide range of temperatures, without pumping or priming; a high-temperature flame (about 2300 F), and very nearly complete combustion. Bottled-gas producers also point out that a small cylinder lasts a surprisingly long time. The refrigerator, for instance, can freeze ice cubes, has nearly a cubic foot of storage space, and will run for 50 to 60 hr on a single cylinder of gas.

LPG soldering torch works in combination with ultrasonic vibrator in this Gulton Industries unit. Ultrasonic generator (right) can also be used with electric soldering iron.

DEVELOPMENTS TO WATCH...

Bright-plating process for antimony . . .

. . . is available, and recent Battelle Memorial Institute tests indicate bright antimony finishes can protect steel. They seem superior to zinc coatings in salt spray tests; and would not be much more expensive. Outdoor tests are so far inconclusive; but, says Battelle: "antimony does appear to be feasible as a thin coating for relatively short exposures to corrosive conditions." So far, no one has used bright antimony plate commercially, and one reason has been cost. But the recent cut in antimony prices (to 29¢/lb domestically; 24 to 25¢ in foreign markets) makes it worth another look.

Rotating shaft seal . . .

. . . that will prevent helium leakage, and operate at 25,000 rpm, 1000 psi, and 1350 F for "thousands of hours is being sought at Batelle Memorial Institute. This is a seal that would be suitable for use on a nuclear reactor turbine-compressor unit, and the development is under Army Engineer contract. It points up again the tremendous mechanical problems involved in reactor design, and adds still another to the number of approaches now being made to the sealing problem. (For a quick rundown of five types of drive seals already being tested, see *PE—Dec. 30, '57, p. 5*).

Appliance hose that won't shrink under pressure . . .

. . . is promised as a result of "the first major change in hose-building since 1904." Says Goodyear Tire & Rubber Co: "Conventional braided hose shortens in length as much as 18% under pressure," straining couplings and necessitating frequent adjustments unless the hose is over-long to begin with. But the new Acala process, now going into volume production at Goodyear's North Chicago plant, is said to produce dimensionally stable, long-length hose that will be useful not only in such home appliances as washing machines, but also in power steering systems and truck air brakes.

Missile problems in design and materials . . .

. . . are highlighted by these quotes from William Holaday of the Dept. of Defense:

Quite aside from the thermal problems involved in high-speed flight, Holaday says, the technological race in the development of missiles extends our needs "far beyond the experience of the industrial and academic world.

"Extremely high altitudes bring up the question of irradiation we may encounter.

"There is also the problem of behavior of materials subjected to nuclear radiation.

"Another problem of considerable importance is that of high-intensity sound. It has been observed that the sound energy of a jet motor or rocket motor may cause fatigue failure of aircraft surface plates.

"This all conspires to create a situation where we must revise and add to our basic design criteria. . . . Simple materials are not sufficiently good to meet our engineering needs. Consequently, composite structures made up of metals and plastics held together by adhesives, or any one of an infinite variety of combinations, may prove desirable.

"We have very little engineering design data regarding the behavior of materials in sandwich or other forms of composite structure. This is an important and highly neglected field of materials engineering." Obviously, it is one that deserves close attention, and it's being covered in a series of articles in PRODUCT ENGINEERING. (See PE—Jan. 20, '58, p 70; and Apr. 28, '58.)

Fully sealed switches for 1000 F and above . . .

. . . are being developed to meet the requirements of supersonic bombers and other high-performance equipment, R. E. Jenner of Minneapolis-Honeywell told an IRE meeting last week.

There are some unsealed switches on the market today which can operate at 1000 F; but "the need for fully sealed high-temperature switches is very real." He also pointed out that new methods of wiring and termination will be needed for switches like these. "The switches now being produced," he noted, "are already so small that applying plugs to them is unrealistic." —ARC

US Gears for 5 Rocket Flights to Moon

WASHINGTON—The White House flashed an official green light last week on plans for the first US flight to the moon.

The Defense Dept.'s new space organization, the Advanced Research Projects Agency, was authorized to take on a program of four and possibly five rocket shoots to the moon. ARPA, in turn, has directed three military field agencies–as distinct from the military departments in Washington–to start work on different phases of the program:

The Army ballistic missile agency, Huntsville, Ala., was told to use modified Jupiter-C rockets for one and possibly two moon shoots, and for launching three more Explorer earth satellites. This is the rocket originally designed as a re-entry test vehicle for the Jupiter IRBM, and which has successfully launched two of the three earth satellites now circling the earth. The Huntsville plant was allocated $5-mililon to get the work under way.

The Air Force Ballistic Missile Div. at Los Angeles, Cal., was initially allocated $3-million for three moon shoots. Its launching vehicle will consist of the Douglas Aircraft-North American Aviation Thor IRBM as the first stage, the Navy Vanguard's Aerojet-General second-stage motor as the second stage, and a third-stage rocket yet to be selected (most likely a solid-propellant engine). Guidance and control equipment will presumably include the Minneapolis-Honeywell and Sperry-Rand apparatus developed for the Vanguard earth-satellite project. Negotiations are under way for contractors to assemble the moon-launching rocket, to produce parts for the lunar payload, and to develop advanced guidance components.

PRIVATE FIRMS UNLIKELY

The Naval Ordnance Test Station, Inyokern, Cal., which developed the Sidewinder air-to-air infra-red guided missile, was initially allocated $200,000 to develop a "mechanical ground-scanning device"–simple instrument to be carried in the rocket payload for examining the moon's surface. NOTS is unlikely to contract much if any of its assignment to private firms.

Although the initial installment of the project's cost comes to only $8.2-million, the final total will probably run over $100-million.

A few days after ARPA revealed the moon-shoot plans, Pres. Eisenhower recommended to Congress that the National Advisory Committee for Aeronautics–the old-line government agency in charge of basic aeronautical research for both military and civil applications–be given over-all control of United States space exploration projects.

ARPA would continue to run purely military space projects under this proposal. But its continued role as supervisor of the scientific moon shoots, assuming NACA's final designation as the top space agency, remains up in the air.

LAUNCHING BY NEXT MARCH

Although no official timetable for the moon shoots has been revealed, most observers expect the first launching attempt to be held within 12 months. Most of the required hardware–rocket engines, airframes, guidance, instrumentation, and the like–is already on hand. The Air Force has already said it could land a payload on the moon by Dec. 31, containing a radio transmitter to signal the earth and a spotter charge to visually mark the impact area on the moon's surface. Army officials are similarly optimistic.

Solving a Corrosion Mystery

LONDON—A type of corrosion never before encountered which induced piston seizure in the control systems, wrecked the 60 MW turbo alternator at the Uskmouth power station of the central electricity authority, Jaunary 18, 1956. This type of corrosion was revealed by an investigation, details of which were given last week before the Institution of Mechanical Engineers.

Disaster was initiated by the accidental tripping of the main exciter. The steam valves remained substantially open for a period estimated at 13 sec after load rejection and caused a turbine overspeed condition of 70% (5,000 rpm).

The low-pressure turbine, its shaft and the generator rotor distintegrated and debris was scattered over a wide area killing two people and injuring nine others. The plant had only recently been commissioned.

Because of many baffling inconsistencies related to the nature and sequence of failure, a large investigating committee including many experts from government research laboratories were mobilized.

It was established that a dilute solution of sodium chloride present in the oil system as a result of sea water leakage had attacked the piping and caused the deposition of finely divided pure magnetite on the piston, cylinders and valves in the control mechanisms. As a result of the reciprocating motion, these particles were compacted into an extremely hard interference film.

This interference was sufficient to prevent the oil release valves from rising when all the trips associated with the control governor and the over-speed governor had been thrown. The valves only finally moved when excited by the vibration of the plant just before it broke up.

Accounts from survivors and the results of a preliminary survey had proved confusing. Evidence suggested that serious overspeeding had not occurred and that the protective systems had functioned properly. Trip circuits, turbine emergency valves, relays were all found to be in order, and such damage as there was to the governing and protection systems appeared to have been caused during break-up.

Very little steam had escaped and the steam valves were found closed after the accident. Eventually extensive metallurgical examination of the debris ruled out defective materials and clearly established extensive overspeed.

(continued on next page)

These facts together with the known condition that the main steam valve solenoid had been fully energized positively suggested that some unusual seizure condition in the control valves and relays must have existed.

Ovality, leading to slight piston interference in at least one power cylinder had been discovered earlier. But as this cylinder had been broken during the accident it was considered that the distortion was due to a release of internal stress during fragmentation. A more stringent test for this condition revealed cause of ovality to be deposit of an extremely hard, black iron oxide film about 0.001 inches thick. The shiny black appearance of this film had been noted earlier also but had been dismissed as a normal burnished cast iron surface.

Using X-ray diffraction techniques and an electron microscope the film proved to consist of extremely small particles of pure magnetite (FE304) averaging 0.05 microns. The presence of such a film had not previously been encountered in Britain and a further committee of physicists and chemists was set up.

Test showed that the only possible reagent which could lead to the presence of such finely divided magnetite in the oil system was a dilute solution of sodium chloride. It was assumed therefore that esturarine water had leaked into the oil cooling system. It was further established that the pipe metal-saline reaction only proceeded in the presence of free oxygen and would not have occurred if the system had been running full.

The control and lubricating system of the doomed set however had been drained several times since its commissioning during shut down. This left pools of oil forming corrosion cells throughout the pipework at which the necessary air-liquid-metal interfaces pertained.

Recharging the oil system caused a deposition of the magnetic formed during shut down in piston and valve recesses. Final link in the disaster chain proved to be a compaction mechanism induced by the slight reciprocation motion of the valves and pistons.

That the interference film had been progressively developing was shown in the history of this particular plant which recorded references to stickiness of the power pistons.

ASME, ARS Tussle with Problems of Flight Design

DALLAS—Mechanical engineers in the aircraft industry gathered here for a four-day tussle with design problems looming for high speed aircraft, missiles and space flight. The gathering was sponsored jointly by the ASME and American Rocket Society.

In a paper on "Operational Integrity on New Aircraft Systems," John de S. Coutinho, Grumman Aircraft Engineering Corp, told a session that the explosive increase in magnitude and complexity of aeronautical equipment requires new design tools to assure operational integrity of new equipment.

New equipment, says Coutinho, is developed on a trial and error basis that requires a long and expensive period of debugging. And, "as soon as something new is developed, additional uses are invented for it and the new equipment is never quite satisfactory for the unseen applications.

"On a project involving hundreds of designers, all of whom are concerned with the integrity of the design, each individual designer arrives at many of his decisions on the basis of an intuitive evaluation of his personal experience guided by his common sense. Each decision is based on only part of the accumulated experience of the group, and in many cases no two designers will make the same series of decisions, even if no error is made.

"As a first goal," Coutinho continues, "it seems desirable to develop systematic and objective methods of applying the full weight of all the accumulated experience and ability of the group to the elimination of errors and to the formulation and coordination of each and every key decision on the project."

Coutinho says the integrity problem in some respects is similar to the weight problem before quantitative techniques provided each individual designer with an individual target compatible with the over-all goal.

"Progress in certain specialized fields has been so rapid, and engineers in these fields have been so busy solving their specialized problems, that they have not had time to assimilate principles well established in other fields of engineering."

"We must," Coutinho concludes, "take advantage of all modern means of communication and all new techniques of organizing information to consolidate the experience of a large design team and to bring the full weight of this consolidated experience to bear quickly and effectively on each of the key decisions which are continuously being made by hundreds of individual designers working on a new project."

R. A. Wells, Gulf Oil Corp., commenting on use of boron fuels, says a solution to the problem of fuel deposits on afterburners is to replace the afterburner unit after each flight.

Wells says cost is relatively small. Such a solution also means that the unit would not have to be cleaned in between flights. Boron fuels present no problems in ramjets because there is nothing for the fuel to stick to.

Testing boron fuels, however, has been limited so far, Wells pointed out, because only small amounts of the fuel are available. As research continues, new methods for handling them will become available.

Ejection-seats now in use could have been designed six years ago with proper research funds, said C. W. Russell, Asst. Project Engineer, Republic Aviation Corp. Lack of research funds is now handicapping design of supersonic escape systems.

Russell says we are at the border line where aircraft speeds require more complicated mechanisms to satisfy the physiological requirements of escape systems. Major deterrent is lack of information on basic problems. Argument against deflecting funds to research is that planes spend very little time at supersonic speeds and supersonic bailouts are rare.

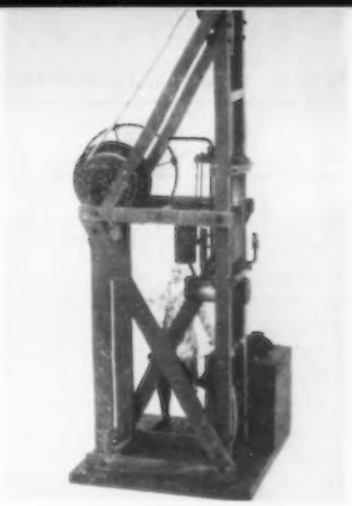
Tests now under way will probably supply the industry with significant data. Sled tests on a Republic capsule will yield interesting data to industry generally but the system is being designed for a specific plane. Looking beyond supersonic flight, an escape system for space will take an entirely different configuration, says Russell.

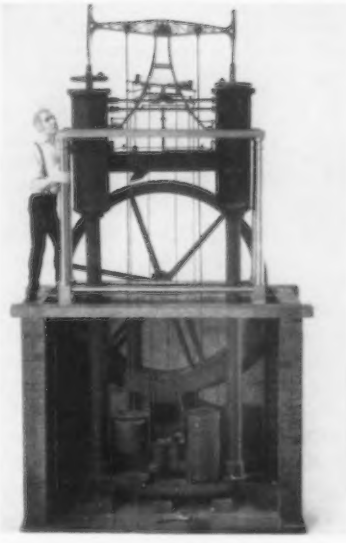
Right, top, John Fitch and the steam engine he demonstrated in a boat in Philadelphia in 1787. The engine drove a set of oars arranged in a rack towering over the boat.

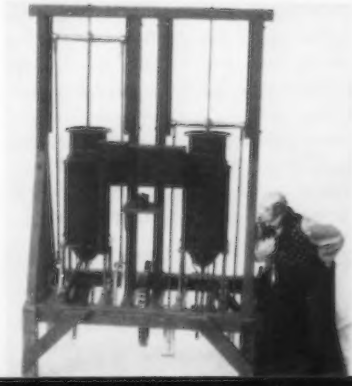
Also used on a boat was this engine, second from top, developed by James Rumsey in the United States in 1787 and later patented in England. It propelled the boat on the jet principle by ejecting water through the stern.

Burning city gas, this internal combustion engine, third from top, designed by Samuel Brown in 1823, was developed to power vehicles. It was once used to pump water.

Bottom, using Brown's principle, Samuel Morey developed this turpentine burning engine in 1826. This engine, which probably introduced the carburetor, lost out to the steam engine as a source of locomotive power.







Reconstruct Extinct Engines

WASHINGTON—A fire in the Patent Office in December, 1836, destroyed all of the records prior to that date, and with them information on such landmarks as the world's first steamboat engines built by John Fitch and James Rumsey in the 1780's. The first internal combustion engine built in America, by Stephen Morey in 1826-28, is unknown to most specialists in this field.

For an exhibit of the history of power machinery, specialists at the Smithsonian Institute in Washington, D. C., dug into the records of the time and came up with enough information on the engines to attempt their reconstruction.

Shown at right, top, is a model of a steam engine built by John Fitch in 1787, designed to drive a set of oars through a ratchet mechanism. With this engine Fitch offered steamboat service, probably the first in the world.

Fitch was competing with James Rumsey, whose engine, right, second from top, was built in 1787-88. The boat was operated on jet principle. The engine had a steam piston above and a water pump piston below, ejecting water through the stern.

Don Berkebile of the Smithsonian Institute works on a model of the Samuel Howd water turbine, invented in 1838. This was the forerunner of the Francis turbine, still the most common hydraulic turbine.

The "gas-atmospheric" engine, right, second from bottom invented by John Brown in England in 1823, was the first internal combustion engine to be used industrially. It had no piston. Gas burners within the cylinders heated the air and expanded it through the open top. As the rocking beam above lowered the "lid" onto the cylinder, the gas was extinguished, and the cooling of the cylinder created a partial vacuum, drawing water up from below. As the cycle continued, this water flowed out over the water wheel behind, producing rotary power.

Three years later, an American, Samuel Morey, used the same principle to make a less complicated engine, right, bottom. Morey's engine had a piston like Brown's, but relied for its power on the reaction of the atmosphere against a partial vacuum, rather than the explosion itself. Brown used city gas in his engine, but Morey used turpentine. It is thought that his engine probably introduced the carburetor. Morey tried to get his engine used in the then new railroad locomotive, but he was passed over in favor of the steam locomotive.

Donald Berkebile of the Institute, who was in charge of the project of reconstructing models of these extinct species of power machinery, feels that his most successful attempt was a model of a center vent water turbine, at left, which was patented by Samuel Dowd of Geneva, New York in 1838. It came to the attention of James B. Francis, a hydraulic engineer of Lowell, Massachusetts, who modified it slightly and started its career.

WASHINGTON BUDGET REVIEW:

Production, R&D for Military on Rise

WASHINGTON—The volume of military contracts for weapons production and research and development is rising sharply. Two factors are providing the impetus:

The administration's post-Sputnik shift in defense planning. Spurred on by Congressional criticism about serious lags in U.S. military preparedness—notably in missiles and satellites—the White House and the Pentagon have lifted last year's restrictions on defense expenditures, have laid groundwork for a steadily increasing rate of spending over the next few years.

The administration's new plans to counter the business recession. Some of the defense spending boosts stem mainly from efforts to push government business into regions hard hit by unemployment. Example: $100-million worth of truck and trailer production contracts to be placed during March and April in Illinois, Indiana, Michigan, Ohio, and Pennsylvania.

Here's how the rate of new contract awards for weapon production is rising: July-September 1957, $2.2-billion worth of orders; October-December 1957, $3.9-billion; January-March 1958, $4.9-billion; April-June 1958, $5.1-billion.

Under present production schedules, $8-billion worth of new contracts will be placed during July-December 1958 and $7.4-billion during January-June 1959.

But these sums are sure to be substantially raised. PRODUCT ENGINEERING learned the Pentagon was putting finishing touches on a supplemental appropriation request of roughly $2-billion to be added to the fiscal 1959 budget sent to Congress in January.

The extra funds will be earmarked for continued production of:

Boeing's B-52 heavy bomber and KC-135 jet tanker (both now scheduled to halt by the end of 1959);

Construction of at least three more $80-million atomic submarines armed with the Polaris IRBM and accelerated output of the missile; development and launching of new space vehicles and satellites; the Air Force's new "Minuteman" solid-propellant ICBM;

A step-up in the Air Force's liquid-propellant Martin Titan ICBM project—with special emphasis on research for liquid rocket fuels more easily handled and stored than present liquid oxygen-type-combinations; and speed-up of the Nike Zeus anti-missile missile development project.

In all, military research and development contracts in the current fiscal year 1958 will total at least $1.8-billion—up slightly from fiscal 1957 which ended last June 30. In fiscal 1959, starting next July 1, the total will exceed $2.2-billion.

For production contracts, the total for fiscal 1958 will be $15.2-billion slightly more than last year's sum. In fiscal 1959, new contract awards will total at least $15.4-billion.

Placement of contracts awards originally scheduled during calendar 1957 was badly delayed by last year's budget-balancing freeze on defense spending. As a result of the significant switches in defense policy since then, the volume of new orders is rising some 50% during January-June 1958 over the previous half-year.

This is how the increases shape up:

Aircraft—From $3.5-billion in July-December 1957 to $4.7-billion in January-June 1958;

Missiles—$1.2-billion to $2.2-billion; Ships, $669-million to $983-million; Electronics and Communications—$238-million to $802-million; Combat and support vehicles—$52-million to $332-million; Ammunition—$103-million to $301-million; Production equipment and facilities—$124-million to $239-million; Artillery and other weapons—$13-million to $38-million; and other major procurement—$110-million to $338-million.

Looking ahead to fiscal 1960, the outlook is for still more hikes in spending for military hardware. The three services have put together preliminary budget estimates totalling $49.6-billion in new funds. This is $10.5-billion over initial request for fiscal 1959.

Design Engineers Lend an Ear to Biophysicists

NEW YORK—Design engineers at the IRE conference here turned to biophysicists for guidance. Among the most subtle instruments known are the transducers nature installs in living organisms—eyes and ears, for example.

Biological transducers convert electromagnetic radiation or other energy into nervous action. They are of a complexity, and operate with an efficiency, enormously superior to data handling equipment designed by engineers.

Investigation of nature's transducers is sufficiently keen for the IRE to include a panel of biophysicists on the program of its annual convention. Though the research reported by the panelists has no immediate practical application, it will inevitably have profound significance for data processing equipment and engineering design.

Biological transducers keep a plant or animal informed of changes in its environment. New information is transferred to a process center, weighed against the record of old experiences stored in the memory and a program of action emerges. In addition, the organism can learn from experience.

Typical of panelist's reports was a discussion on eyes of horseshoe crabs. By attaching an electrode and amplifier to a nerve fiber in the crab's eye, the investigator learned that steady light inhibits passage of electrical impulses from one neuron to the next, but a change in intensity excites the neurons. From test results, the investigator concludes that the eye is a selective instrument. It sorts out significant information for the crab rather than a faithful reproduction of the environment.

Other panelists discussed the interaction of groups of neurons with the neuron next in line along nerve fibers and animal behavior patterns that cannot be tied to changes in environment, no matter what the circumstances.

Shipyards Trim for New-design Building Spurt

WASHINGTON—A big government-backed shipbuilding program is looming on the horizon that promises to bring new designs in ship construction. With virtually all of the US merchant fleet slated to be replaced with modern vessels over the next 10 to 15 years, designers are looking for new ways to build the ships.

Being proposed are ships that use preloaded boxcar size containers for toting cargo rather than the present hand loading and stowing method. New propulsion being considered includes diesel engines that are equipped to burn low cost petroleum fuels, new steam turbine engines, and a free piston generator gas turbine. The new types of propulsion are now all being tested in three government-owned Liberty ships.

Other changes that might turn up in new ships are controllable pitch propellers that can be trimmed to meet varying sea conditions, fin stabilizers to cut down roll of ships and big new mechanical cranes for handling cargo.

The ship designers, too, are looking for wider use of plastics in new ships for lifeboats, and other auxiliary equipment. And, some internal construction items such as plastic pipes may be built into the ships.

The boom in shipbuilding is coming in spite of the current slump in ocean freight rates that is forcing many ships to lie idle for lack of cargoes. Reason is that the freight market can change overnight and put ships back in demand; it takes a couple years to build ships. They are planned over a 20-year period.

The cargo ship replacement program that is beginning to unfold promises to add an estimated $3-billion in contracts over the next 10 to 15 years. The government will pay around 45% of this through construction subsidies. In all, close to 250 new cargo ships are slated to be built. Yards now have 116 contracts— including major conversion—valued at $1.2-billion either under construction or on order.

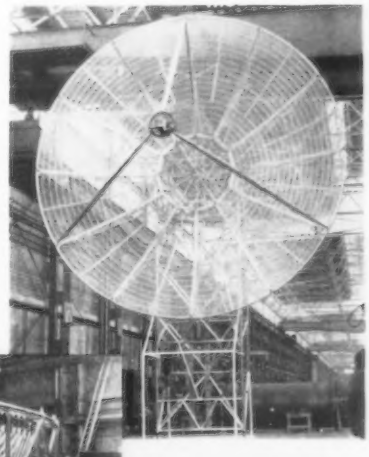
By and large it takes from two to three years to build a merchant ship. Spending starts shortly after contracts are placed. Then, long lead time items such as steel and machinery are ordered. Generally, the cost of a ship breaks down to roughly 50% for material, 40% for labor and 5 to 10% for profit.

Steel for building the hull of the ship costs about 10% of the total construction cost; machinery accounts for around 20% of the cost; electrical equipment for the ship's electrical power system accounts for around 5%; and outfitting the vessel runs around 15%. Outfitting comprises virtually everything that goes inside the ship, including internal steel structure of the ship plus the above deck cargo handling facilities.

Increased demand for oil around the world, and the Suez crisis, sparked the tanker building.

Highly mobile dish . . .

. . . is this 28-ft sectionalized, welded-aluminum parabolic reflector that rolls around easily on retractable wheels, in its own antenna tower. The antenna is particularly adaptable to scatter-propagation site surveys. Easily towed by an ordinary car, the combined weight of the trailer and load is 3300 lb. The design cuts shipping costs by 60%. Unpacking and assembling takes less than four hr.



Bits and Pieces

Japan's ordnance industry would like to send a mission to the US to discuss the possibility of Japanese manufacture of US-designed guided missiles. An industry-to-industry exchange of information through licensing and patents arrangements would be the best way around the anti-rearmament sentiment in Japan. Japanese scientists claim much of their World War II research on infrared guidance is contained in US Sidewinder missile . .

The Society of German engineers (VDI) has formed a US branch to "establish connections, working cooperation, and an exchange of experience in the engineering field among engineering societies and technical enterprises in the US and Germany." Founded in 1856, the society has 34,000 members . . .

Improved electronic-computer packages have been developed at the National Bureau of Standards. Although the packages perform the functions of those previously developed, they require less power and less cooling. Similarity of most circuit stages suggests use of mass-produced packages.

The yet-to-be-unveiled X-15 rocket plane, designed to carry man at speeds over 3600 mph at altitudes above 100 mi will have stainless-steel skin and wings to cope with the high temperatures encountered at that speed. Few fasteners will be used; the plane will have about 65% welded structure. Hydrogen peroxide jet streams in the nose and wing tips will be used for control at high speeds. The plane will land on steel shoes and a conventional nosewheel. It is expected to fly sometime in 1959 . . .

Aerojet General Corp. and the Post Office are cooperating in a study for carrying mail in rockets at supersonic speeds in a transcontinental tube. The same materials used for the military rockets will be used in the tube.

READER TO EDITOR

To the Point

To the Editor:

In your March 10 issue (p. 62) under "Why Don't They Research and Develop," one of your readers, H. Belofsky, feels a need for a pencil pointer, powered by a hollow shaft machine. The Charles Bruning Co., too feels that all draftsmen and engineers should have a powered pencil pointer.

The Bruning Pencil Pointer is comprised of a machined aluminum housing and four precision-ground blades. The tapered pointer shaft fits snugly into the top of its power source, the hollow shaft eraser. As the pointer rotates, a conical point is produced on a mechanical pencil. The graphite is trapped inside the aluminum housing. After considerable use the blade can be replaced. The knurled aluminum housing will last indefinitely.

The electric erasing machine sells for $22.55, and the pencil pointer $1.75.

—Edward Brown
Charles Bruning Co., Inc.

Unbreakable Dispenser

To the Editor:

In "Why Don't They Research and Develop" (Feb. 24, p. 50), you requested an unbreakable dispenser for powdered detergents. Bell-King Distributors is now marketing such a cleaner. The product is sold under the name of SURE SLIK Heavy Duty Hand Cleaner in an 8-oz soft plastic bottle. It is primarily for those working people who want a fast and thorough hand cleaner. The product retails for 89¢ per bottle.

—Robert D. Johnson
Secretary
Bell-King Distributors

Built-in Vacuum System

To the Editor:

We note with considerable interest your article about a built-in vacuum cleaner for homes, (Jan. 27 p. 58). We have been on the market with such a system for the past three years.

Our system does not connect into the sewer system, but instead uses a cyclonic separator, from which the exhaust of air goes to the outside atmosphere. We have done considerable research regarding a system connecting into the sewer system, but find that there are many problems that make it impractical from a cost standpoint, as well as from the standpoint of conflict with the local sanitation codes. We think your cost estimate of $200 for such a system is too low; however, our system can meet this figure.

—N. E. Hovey
Director of Sales
H-P Products, Inc.

Latin Squares

To the Editor:

The article discussing reliability standards for fiber-reinforced plastics (Feb. 3, p. 69) was of great interest. We have used orthogonal Latin squares, an extension of Graeco-Latin squares, in our multivariate problems. The programs have been used on IBM computing machinery here for some time. A paper was presented by Mr. N. M. Peterson, of Convair, on this subject at the meeting of the Institute of Mathematical Statistics in Los Angeles in Dec., 1957. It appears that the coordination of various companies in these research and development projects should greatly accelerate the progress that is being made in the development of new materials.

H. R. Dvorak
Chief of Nuclear Radiation Effects
Convair

• An article dealing with Latin squares to simplify testing will appear in a forthcoming issue—Ed.

Homogeneous, Heterogeneous and Homogenous

To the Editor:

As a result of the increasing amount of publicity about solid rocket fuels, etc., the terms homogeneous, heterogeneous, and homogenous are used with ever increasing frequency. Your article, "Rocket Fuels: Solid or Liquid?" (Mar. 10, p. 23) also uses these terms. Mr. A. F. Gledhill, a mechanical engineer in my group, has brought to my attention a point about these words which was new to me and may be news to many of the other people using the terms these days.

The point is that the words "homogenous" and "homogeneous" are not synonomous. Homogenous, you will note, is a biological term having very little to do with uniform density and uniform mixture commonly associated with the terms homogeneous, homogeneity and homogenized. In the purest sense, two elements mixed together uniformly and uniformly packed are not homogeneous. However, this word seems to come closest to the desired meaning. But homogenous is *not* the word.

I think you will agree that engineers in general and editors in particular should use these terms as correctly as possible.

—Robert W. Jenny, *Supervisor*
Mechanical Development Group
Applied Physics Staff
Boeing Airplane Co.

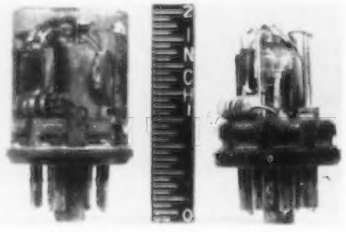
• We agree.—Ed.

Removing Potting Compound

To the Editor:

In reply to Mr. J. Meyer's request (Feb. 24, p. 50) in "Why Don't They Research and Develop. . ." for a potting compound for encapsulating electrical assemblies that could be removed later without melting or breaking the parts, we have an even better answer.

We have been marketing for some time a solvent which will permit the use of many types of encapsulating compounds which may be later removed so that the assemblies may be inspected. Typical of assemblies which have been salvaged are: connector



BEFORE . . . AFTER

encapsulated with silicone rubber, transformer encapsulated with Fosterite, and oscillator assembly (shown in photo) which had been potted with 3M's Scotchcast resin.

As Mr. Meyer anticipated, removal without injuring components is a slow process—a matter of a few hours. The solvent will not harm Formvar enamel, Bakelite resins, aluminum, copper, or other metals.

—W. O. Schlimbach
Secretary
Mona Industries, Inc.

MOLY NEWS

CLIMAX MOLYBDENUM, 500 FIFTH AVENUE, NEW YORK 36, N. Y.

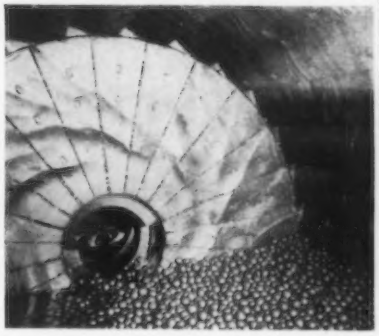
Chrome-Moly Steels Prove Ability To Resist Wear and Abrasion, Cut Costs

Can be Adapted to a Wide Range of Uses

To offset rising equipment and maintenance costs, the savings possible with wear-resistant alloy steels are receiving increasingly wide attention, in a growing number of industries.

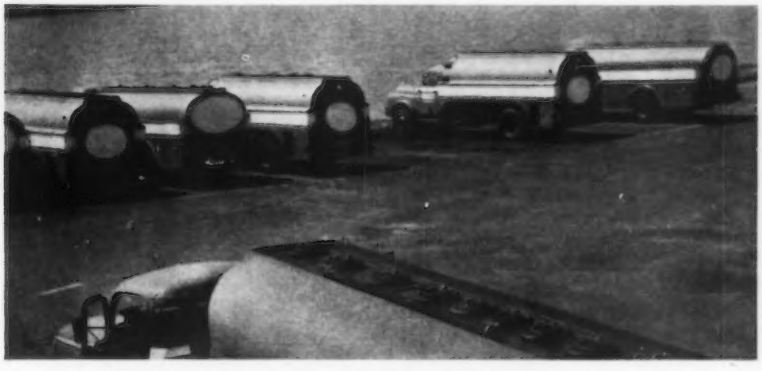
Two types of "Chrome-Moly" steels show exceptional resistance to abrasion and wear under toughest conditions. Both have substantially cut liner costs and shutdown time in grinding mills. Both are suitable for a variety of other industrial applications because they combine wear resistance, favorable first cost, freedom from premature failure by breakage or spalling, resistance to flow in service, consistently uniform performance and adaptability to specific designs.

The two types are Pearlitic (250-450 BHN) and Martensitic (450-700 BHN). Carbon and alloy contents and heat treatments of both types can be varied to suit specific applications.



Note that the spiral wear pattern is clockwise, even though the mill's rotation is counter-clockwise. Type 2 Martensitic steel is used here.

For an article on the use of Chrome-Moly steels, send for "How to Select Chrome-Moly Steels for Ball and Rod Mill Liners" by T. E. Norman, reprinted from Engineering and Mining Journal. Circle #1 on the coupon.



New Use For Super-Strength Structural Steels

Today, gasoline trailer tanks are built of super-strength structural steels for a good reason. The steels have high strength/weight ratios. This factor enables builders to design tanks that carry greater payloads and still meet legal gross weight limits. And the extra capacity pays for the higher trailer cost in a few months!

This use is only one of countless possibilities for utilizing the steels' minimum yield strengths of 55,000 to 150,000 psi . . . and their many other desirable properties. *For more information, including tradenames and compositions, ask for "Super-Strength Structural Steels." Circle #2.*

Sums Up Moly's Resistance to Corrosion

A new paper, "Corrosion Resistance of Molybdenum and Molybdenum-Base Alloys," based on published literature, summarizes moly's resistance to a number of corrosive media. It also lists the reference articles. For a copy of this paper, *circle #6.*

Molybdenum Improves Corrosion Resistance of Stainless Steels

Translated excerpts from two French articles discussing how moly improves the corrosion resistance of austenitic and austenitic-ferritic stainless steels are now available. *Circle #7.*

Special Steels Solve Hydrogen Sulphide Problem

Hydrogen sulphide in France's Lacq natural gas field brought up a metallurgical problem: the need for tubing meeting the N-80 strength requirements but with better resistance to sulphide stress corrosion than the conventional N-80 grade. Two such steels have been developed. One contains chromium, aluminum and molybdenum; the other contains chromium, molybdenum and vanadium.

For articles discussing both steels, send for "A Special N-80 Steel Tubing . . . " by Cauchois, Didier and Herzog, reprinted from *Corrosion*, and "Comments on new French N-80 Steels" published by Climax. *Circle #3.*

Vanadium in Low-Alloy, High-Temperature Steels

Molybdenum is a must in low-alloy, high-temperature steels. However, recent tests at the U.S. Naval Research Laboratory point up the role of Vanadium in such steels, and show the effect of variations in composition and treatment. Addition of Vanadium results in a better high-temperature alloy, but getting the improvement requires higher normalizing temperatures.

The advantages and limitations are described in an *Iron Age article*, "Higher Vanadium Improves Hot Strength of Low Alloy Steel," by Paul Shahinian and J. R. Lane. *For reprints, circle #4.*

New Cleaner Removes Surface Oxides From Moly Metal

A practical, low-temperature method of cleaning molybdenum has recently been developed. It is especially suitable for removing surface oxides prior to welding. The process involves two chemical baths: one at 150-180°F, the other at room temperature. *Digested from "Ryan Devises Molybdenum Cleaner," Ryan Aeronautical Company. For reprints, circle #5.*

Climax Molybdenum, Dept. 61
500 Fifth Avenue, New York 36, N. Y.
I'd like more information on:
1 2 3 4 5 6 7

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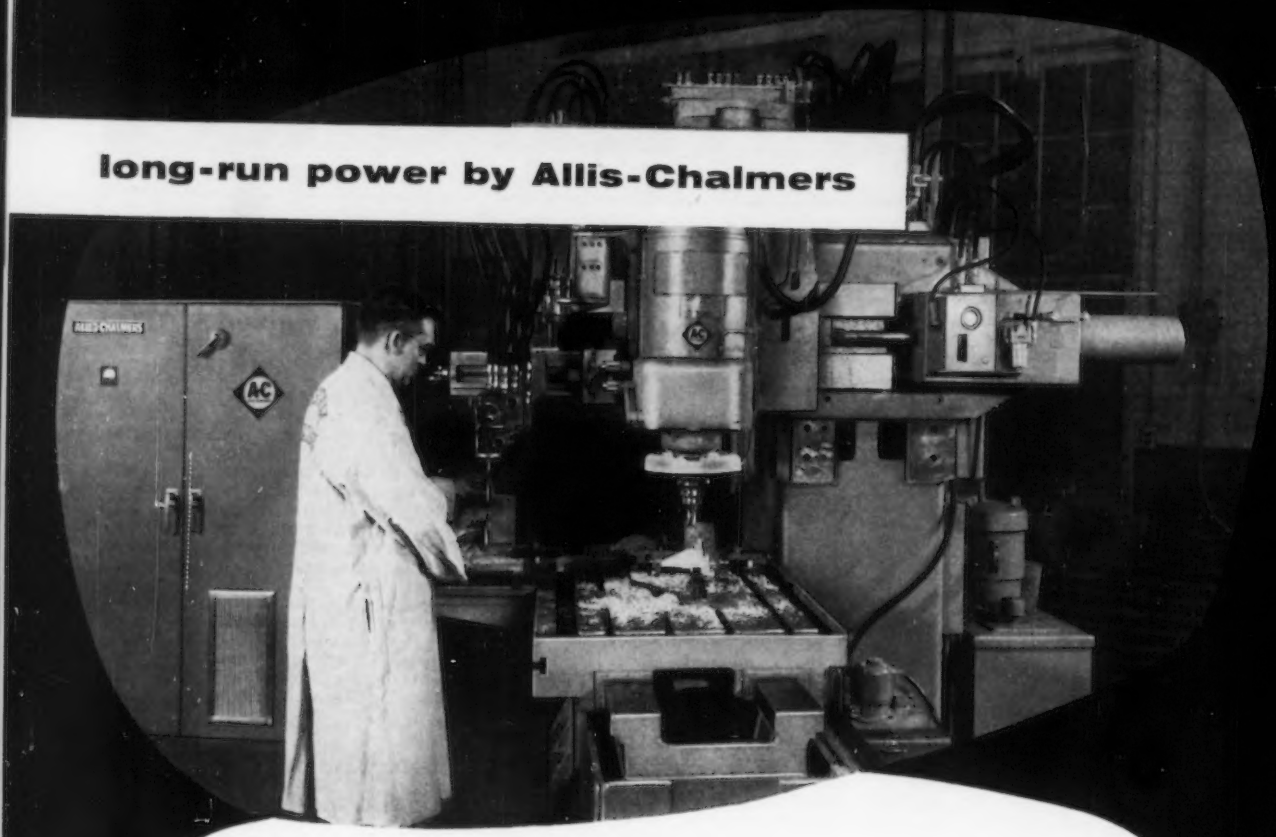
long-run power by Allis-Chalmers



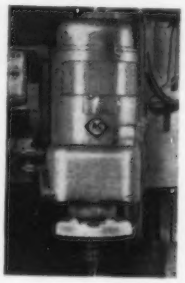
NOW AVAILABLE— 50 to 6000 rpm shell-type, dc water-cooled motor with static controller

THIS infinitely variable-speed motor and control system was designed for a machine tool company for its profile milling machines. Reason: air-frame and missile builders require all-purpose motorized spindles for machining titanium, steel and aluminum.

Special Allis-Chalmers engineering provided a dc shell motor and static control to perform this duty. *With the equipment went A-C assurance of nation-wide engineering service to back operation in the field.*

This is one example of A-C engineering skill. Combined with a broad line of standard motors and national service, it can mean real benefits for your process or equipment.

Contact your A-C representative, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

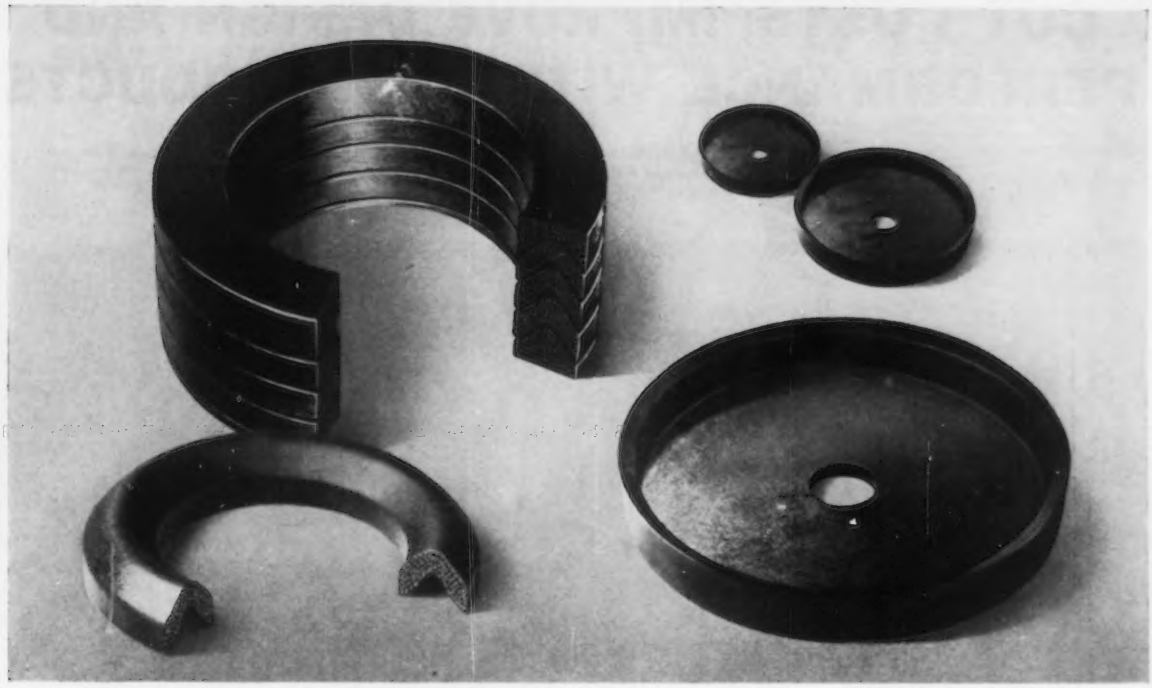


CLOSE-UP of new Allis-Chalmers dc shell motor mounted in customer's housing illustrates compactness. It is water-cooled and has oil-mist lubrication.

STATIC GRID CONTROL, newly developed by Allis-Chalmers, has thyratrons to allow for high and low speed range, and automatic acceleration through the entire range.

A-5730

ALLIS-CHALMERS



R/M Vee-Flex Rings seal automatically and will not roll.

R/M Fabric Piston Cups are precision molded and cleanly trimmed.

PRECISION QUALITY CONTROL MEANS YOU CAN RELY ON R/M V-RINGS AND PISTON CUPS

R/M Vee-Flex® Rings give better performance and cut maintenance costs for your customers. Convex curvature of the surface which touches the next ring makes them self-sealing and self-adjusting. Pressure stroke produces a seal against the stuffing box wall and the adjacent ring. Friction is reduced on the return stroke. Precision molding and trimming give you the best possible fit—and provide longer wear, because the fabric is deeply penetrated by the compound. Use them on steam or air rods, hot oil pumps, hydraulic rams, outside-packed plunger pumps, food handling machinery, accumulator and elevator rams on oil or water service.

R/M Fabric Piston Cups provide minimum friction, long life and accurate fit. Molded from a variety of rubber synthetics with fabric reinforcements to suit your specific requirements. You can see the big difference in their clearly defined contours and cleanly trimmed edges—proof of strict adherence to industry standard sizes. R/M Fabric Piston Cups fit hydraulic and pneumatic cylinders ranging in diameter from ½ to 12 in. They are produced in varying degrees of hardness for pressures up to 1500 psi and in compounds to meet your specific operating conditions. When ordering piston cups, specify R/M.

Complete information on these and many other R/M Packings is given in this free booklet. Send for it today.

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS—Vee-Flex®, Vee-Square,® Universal Plastic, and "versi-pak"®; GASKET MATERIALS; "TEFLON"* PRODUCTS, including flexible wire-braided and rubber-covered hose. SEE YOUR R/M DISTRIBUTOR.

*A. Du Pont trademark

R/M

PACKINGS

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics • Sintered Metal Products • Abrasive and Diamond Wheels
Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

CUT COSTS, IMPROVE DESIGN AND PERFORMANCE WITH R/M PRODUCTS

RUBBER

Write today for free booklet shown: full details on a wide variety of industrial rubber products.
Manhattan Rubber Division, Raybestos-Manhattan, Inc.
Passaic, N.J.

R/M *Poly-V*® Drive

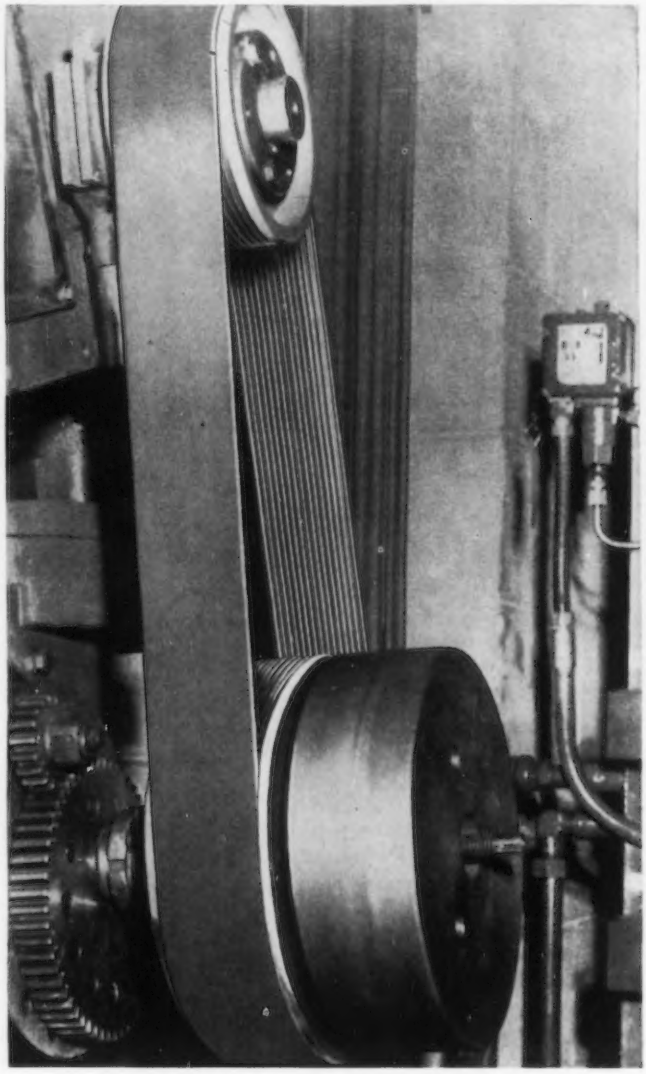
MORE POWER—LESS SPACE

Space saving advantages of R/M's patented Poly-V Drive has proved the answer to difficult drive problems for a wide range of applications. Use of Poly-V on this planetary milling machine, for example, almost *doubled* power capacity of the machine's drive . . . *without* increasing space requirements!

R/M Poly-V Drive employs a single, endless parallel V-ribbed belt running on sheaves designed to mate precisely with the belt ribs. Higher horsepower capacity per square inch of the single unit belt permits use of *narrower* sheaves. You get up to 50% *more* power in the *same* space as a standard multiple V-belt drive . . . or *equal* power in as little as ⅓ the space—with less shaft overhang, less drive weight.

Poly-V's single unit belt completely eliminates V-belt matching problems, helps assure constant pitch diameter and speed ratios from *no* load to *full* load. Stronger, cooler running, longer lasting Poly-V Belt is heat resistant, oilproof and non-spark. Just *two* cross sections of Poly-V Belt meet every heavy duty power transmission requirement. If you have a power transmission problem, let the R/M engineers who developed Poly-V* Drive assist you in determining the drive that will best meet your requirements. Write for Poly-V Bulletin 6638.

*Poly-V is a registered Raybestos-Manhattan trademark.



Wherever your problems require Poly-V* Drives, V-belts, flat transmission belting, conveyor belts, rubber hose, precision molded or extruded parts . . . rely on R/M specialists to work with you.

R/M

Brake Blocks, Linings and Clutch Facings

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

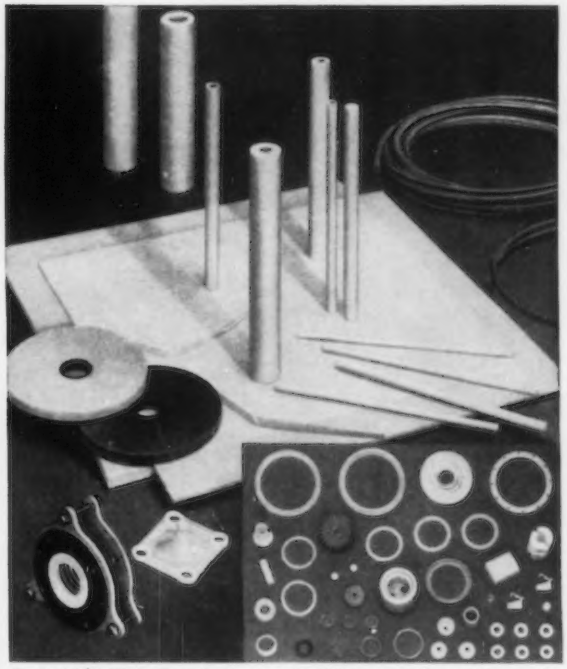
SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

PLASTICS

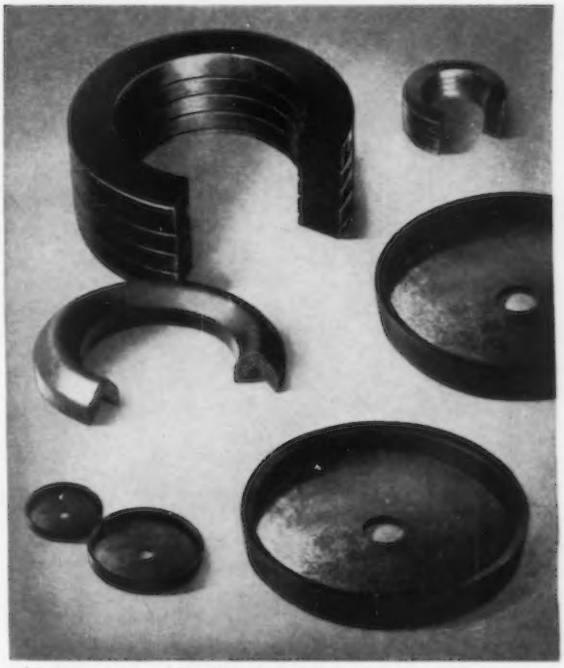
Write for free booklet, which provides valuable information on a variety of R/M plastic products.
Plastic Products Division, Raybestos-Manhattan, Inc.
Manheim, Pa.

PACKINGS

Complete information on packings shown and many others is given in free booklet. Send for it today.
Packing Division, Raybestos-Manhattan, Inc.
Passaic, N.J.



Typical R/M "Teflon" products—wire-braid hose, tape, sheets, tubes, rods, gaskets, expansion joints, etc.



R/M Piston Cups and Vee-Flex Packing Rings are among the many precision engineered R/M Packings

Dependable quality in R/M TEFLON* parts and components

Our long experience and unparalleled facilities suggest Raybestos-Manhattan as your headquarters for any "Teflon" products you may need. R/M laboratories and engineers have had outstanding success in the developing and testing of "Teflon" products. This is matched by R/M's fabricating facilities and resourcefulness. We are constantly turning out those "can't be done" jobs.

We invite you to bring us your "Teflon" problems, especially those which involve close tolerances and intricate design. Whether your need is for steel wire-braid hose, custom-machined or molded parts or components, or applications using bondable "Teflon" sheet or tape, your specifications will be followed with painstaking accuracy. You may be able to use to advantage similar products made of Raylon, the R/M trade name for mechanical grade "Teflon" which has many of the properties of virgin "Teflon."

*A Du Pont trademark

Get better performance from R/M Molded Packings

Accurate molding methods and precise quality controls assure you of outstanding performance when you specify molded hydraulic and pneumatic packings manufactured by Raybestos-Manhattan. Coupled with this is the extra benefit you get from the engineering skills and experience accumulated by R/M over many years as a leading manufacturer of mechanical packings. This advantage is demonstrated in such R/M products as piston cups and Vee-Flex* Rings.

R/M Piston Cups, available in Neoprene or Buna-N and duck or in Buna-N and asbestos. Compounds have been carefully developed by R/M's chemists to give maximum service for a wide range of applications. Low friction, high resistance to extrusion.

Vee-Flex Rings, made in five types, are self-sealing, self-adjusting. Designed to form a tight seal against stuffing box wall and shaft during pressure stroke and to reduce pressure on return stroke. Effective seal at all pressures.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

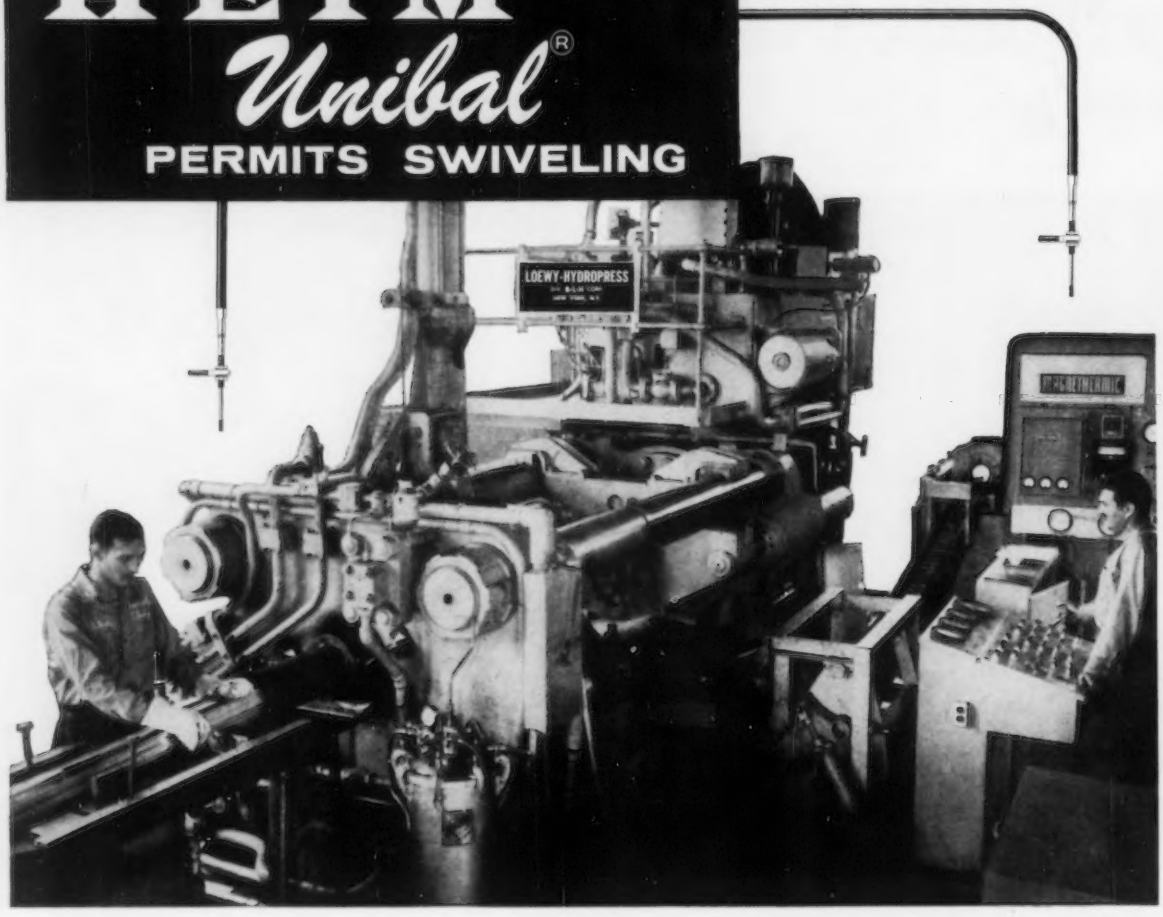
Asbestos Textiles

Industrial Adhesives

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

HEIM *Unibal*®
PERMITS SWIVELING



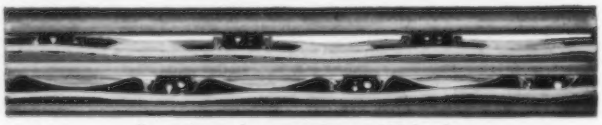
From the pulpit directly to this 1250-ton extrusion press is an ingenious, mechanical, remote push-pull control to which this giant responds. It consists of a solid, flexible stainless steel blade, 24 feet long, moving between rows of stainless steel balls and housed in a flexible tubing. It is called Controlex and is made by Controlex Corp., White Plains, N.Y.

A manually operated lever at the control board, or pulpit, moves the blade in the desired direction, and in order to permit swiveling and for the relief of eccentric thrust on the push-pull end rod, a

HEIM *Unibal*® SPHERICAL BEARING ROD END

is used at the mounting point.

Another Unibal Rod End bearing, mounted at the machine end of the control, completes the swiveling or misaligning action as required.



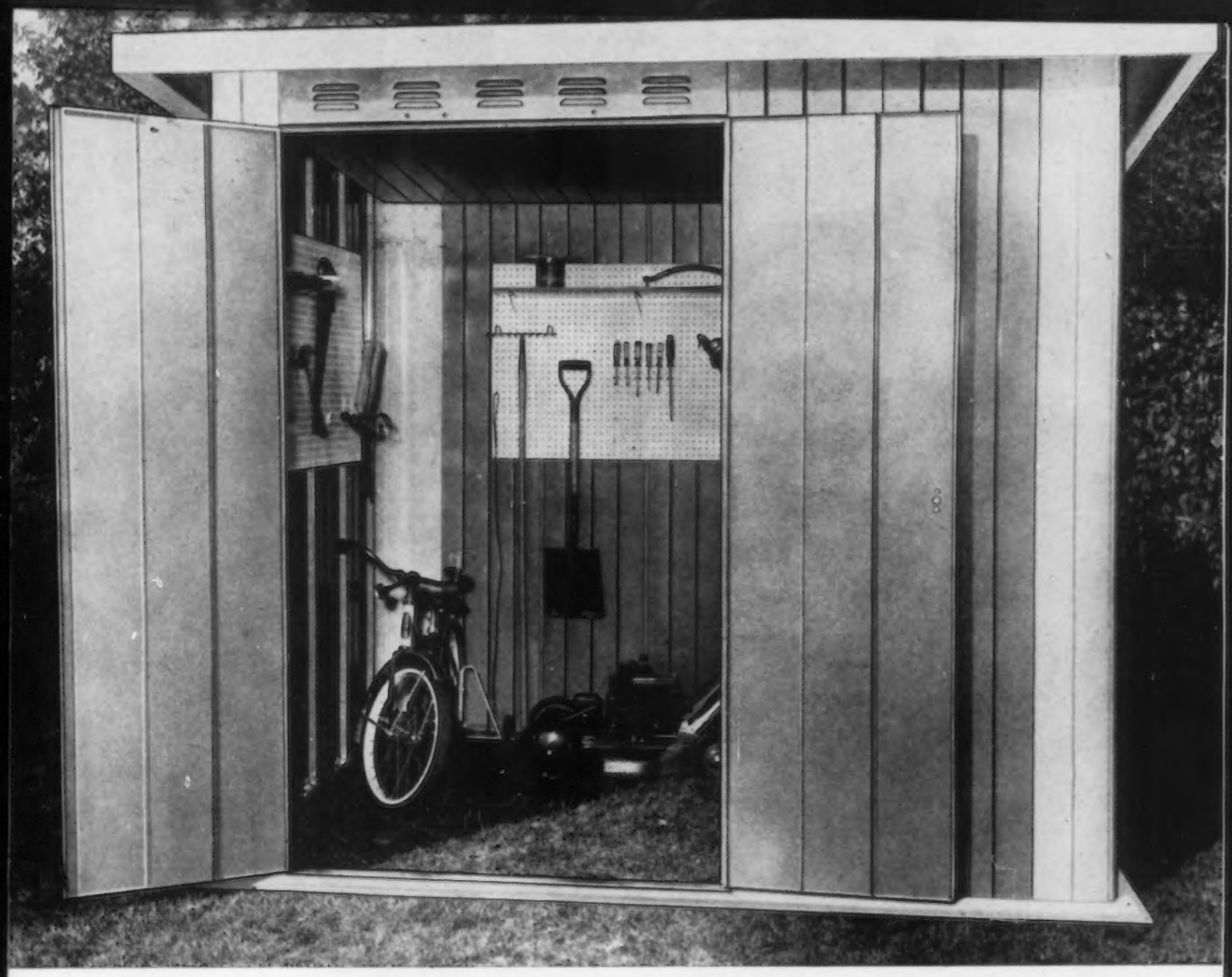
Controlex makes controls over 100 feet long
— a linear ball bearing with 42 balls to the foot.
Press for extruding aluminum strip, built by
Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

This application of the Heim Unibal demonstrates one way in which it serves as a mounting device through which the Controlex end fitting passes. Does it give you any ideas for use on *your* equipment? There seems to be an unending list of possible applications for the Heim Unibal, and our engineering department is ready to help you work out details.

Send for complete Heim bearing catalog

Sold through the leading bearing distributors.

THE HEIM COMPANY FAIRFIELD, CONN.



"WEIRZIN® ARRESTS CREEPING CORROSION,"

SAYS CHIEF ENGINEER OF GRAND SHEET METAL PRODUCTS COMPANY, MELROSE PARK, ILL.

"Especially designed to withstand wind, weather, fire and rough handling." That's the manufacturer's description of a Grand Handy House. Metal used? Weirzin.

But listen to what else Grand Sheet Metal Products Company has to say about Weirzin electrolytic zinc-coated steel, as used in their outdoor storage-shelter-utility Handy Houses. From Chief Engineer Edward Rawson:

> "Weirzin material provides a very good surface for maximum paint adherence, which is most important for an outdoor application such as ours.
>
> "High corrosion resistance is also of the utmost importance. Weirzin answers this requirement very well since it arrests any creeping of corrosion where the surface may become scratched or abraded in service. In other words, the corrosion will not tend to spread beyond the damaged area."

What about your products? Have you considered lately how they can be improved economically? Send for free brochure on Weirzin for both outdoor and indoor use. Write Weirton Steel Company, Department D-15, Weirton, West Virginia.

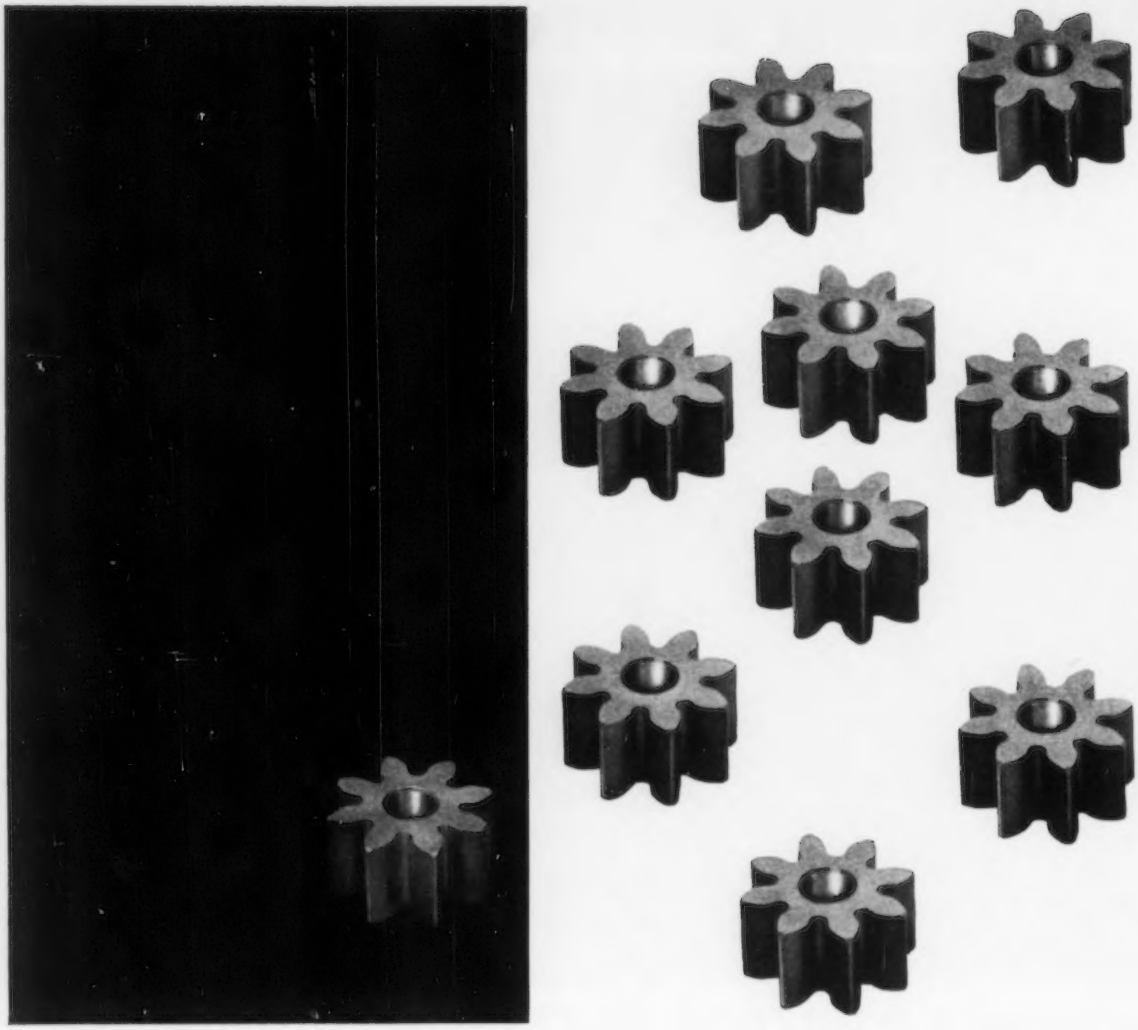
WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION



What about *durability* of sintered metal parts?

Resistance to wear is an outstanding characteristic of the oil pump gears illustrated above. Moraine Products makes them of sintered metals and holds them to exceptionally close tolerances. Gear teeth have unexcelled finish and uniformity. The result is dependable, quiet performance under any operating condition. For this application, as for so many others, long-wearing sintered metal parts by Moraine Products have proved themselves to be the modern, economical answer.

Moraine Products also produces: Moraine Power Brakes • Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts • Moraine friction materials • Moraine-400 and M-100 automotive engine bearings • self-lubricating bearings and porous metal filters • rolled bronze and bi-metal bushings.

GM
FORWARD FROM FIFTY

Moraine Products
Division of General Motors, Dayton, Ohio

DE LAVAL
IMO PUMPS

are now more versatile than ever

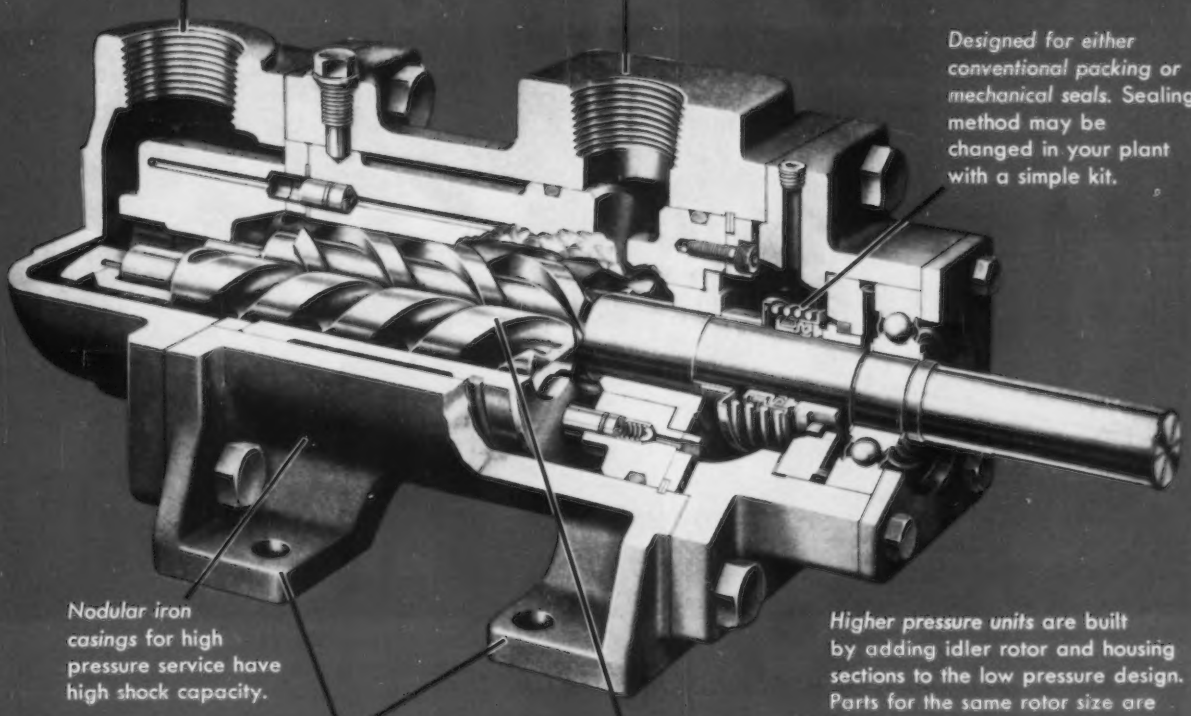
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.



Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

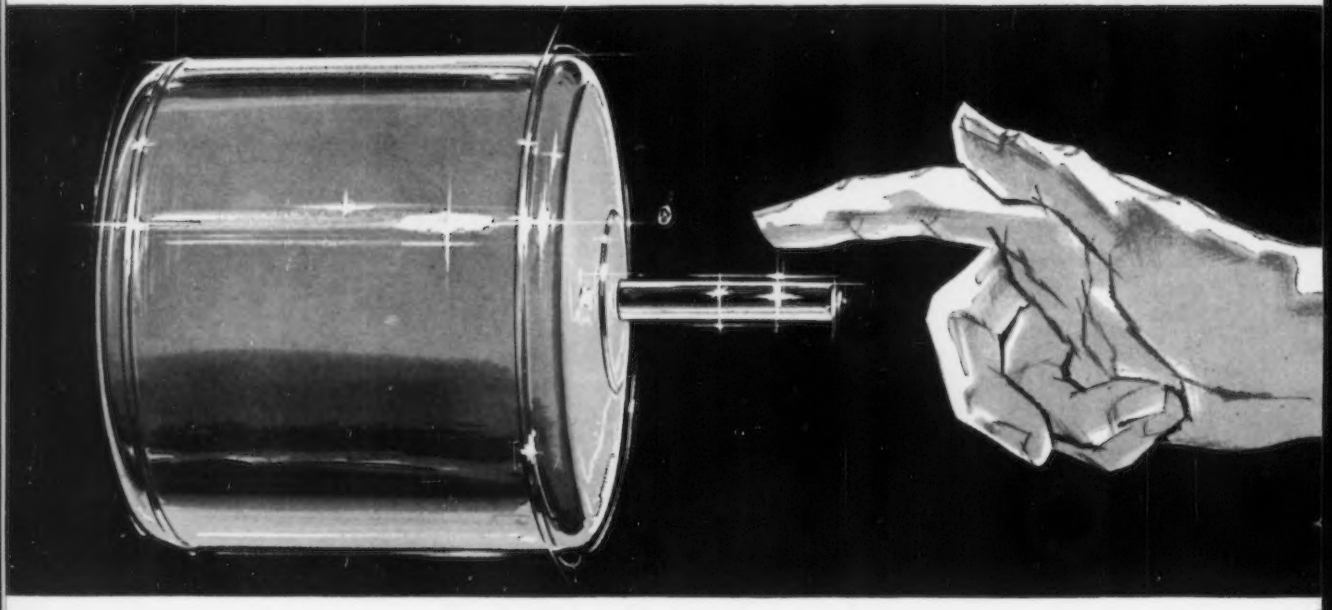
DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

801 Nottingham Way, Trenton 2, New Jersey

DL 419

PACKARD / *advanced research like this*



LEADS / *to advanced appliance motors like this*

Packard Electric uses the latest electronic data processing machines to develop better electric motors. This advanced research method enables Packard to cut design time requirements and to evaluate many motor design equations instead of a few. Once a Packard motor is designed, the complete pilot model is subjected to exhaustive tests. These tests assure production models that will give complete satisfaction under the most rugged operating conditions.

In addition to all this, Packard maintains a staff of engineers to serve as consultants to customers who use the product.

Advanced research techniques, beginning at the drawing board and continuing through actual operation, assure more reliable motors for Packard customers. Meeting the high standards of Packard Electric, these motors are sure to provide the most economical and efficient solution to our customers' needs.

Packard | *Electric*

Warren, Ohio

Division of General Motors

Have you a problem part?

How important is your customer "downtime" to *you?* When your product or equipment fails on the job, it's costing him time and money. Such irritation can lose customers for you!

Is this "downtime" due to a "problem" part . . . a part which continually needs replacing in your equipment? Check your replacement part records *now* to pinpoint any problems. Then take steps to correct them.

AmForge can help you solve these problem parts. Forgings give you savings in material and machining time. They put strength and durability in your product. For years, AmForge has served all types of industry with quality forgings for rugged service. We have the facilities and know-how to tackle *your* problem. It's the kind of challenge we want. Call on our services today! Just write or phone collect.

AMERICAN Brake Shoe COMPANY

AMFORGE DIVISION

155 North Wacker Drive, Chicago 6, Illinois
Plants: Chicago, Illinois (two) • Azusa, California

This descriptive catalog
FREE
16-page facilities catalog to explain what, how and where AmForge can be of assistance to your firm.

AmForge Division, Dept. PE-48
155 North Wacker Drive,
Chicago 6, Illinois

Gentlemen:

Yes, I would like to see your catalog.
Send me ____ copies.

Name_____

Title _____

Company _____

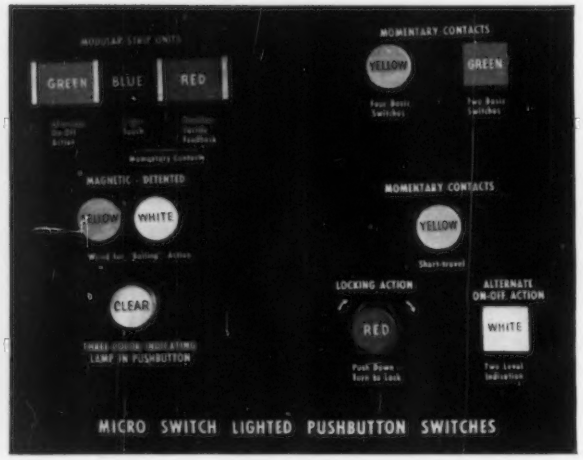
Street_____

City_____ Zone____ State_____

MICRO SWITCH Precision

Highly Reliable MICRO for Electronic Computer

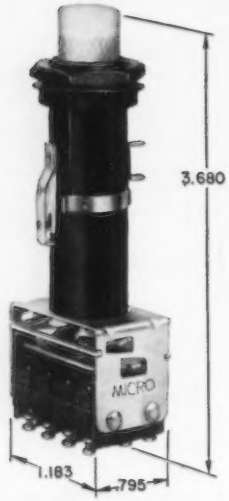
Here are six MICRO SWITCH Precision Switches, designed, produced and thoroughly tested for highly reliable performance in electronic computer consoles, aircraft instrument panels and other types of control panels. . . . The series "PB" illuminated pushbutton and the "AS" series of rotary selector switches typify the best in MICRO SWITCH design and the ultimate in MICRO SWITCH performance and reliability.



Eye Appeal and Positive "Feel" Within Minimum Panel Area

These are the Essentials in Console Design for Today and Tomorrow

Here are two of the many different designs available in Lighted Pushbutton Switches



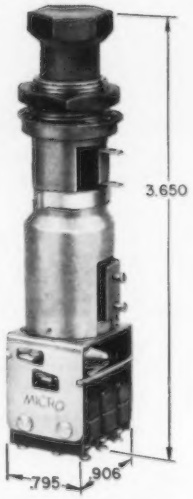
54PB67-T2
with 52PA5 Button

The "50" series switch, shown at left, is a two position, alternate-action switch. The two level visual indication allows extra flexibility in complex control panels. The position of the button—up or down—indicates the condition of the circuit. An independent indicator lamp is free to give additional information, or it can be wired to go "on" and "off" with the switch.

The "50" series switch, at right, is a unique magnetically held push-button. This extremely versatile switch combines multi-circuit switching, indicator light and d-c holding solenoid in one compact unit. When the button is pushed, the switch contacts are held actuated until electrically released. This permits one-by-one "bailing" operation with remote electrical release, allowing complete freedom of panel layout.

These switches are available with two, three or four SPDT contact structures. All lamp and button options may be used. They are rated at 5 amps., 125-250 vac. 3 amps., 30 vdc.

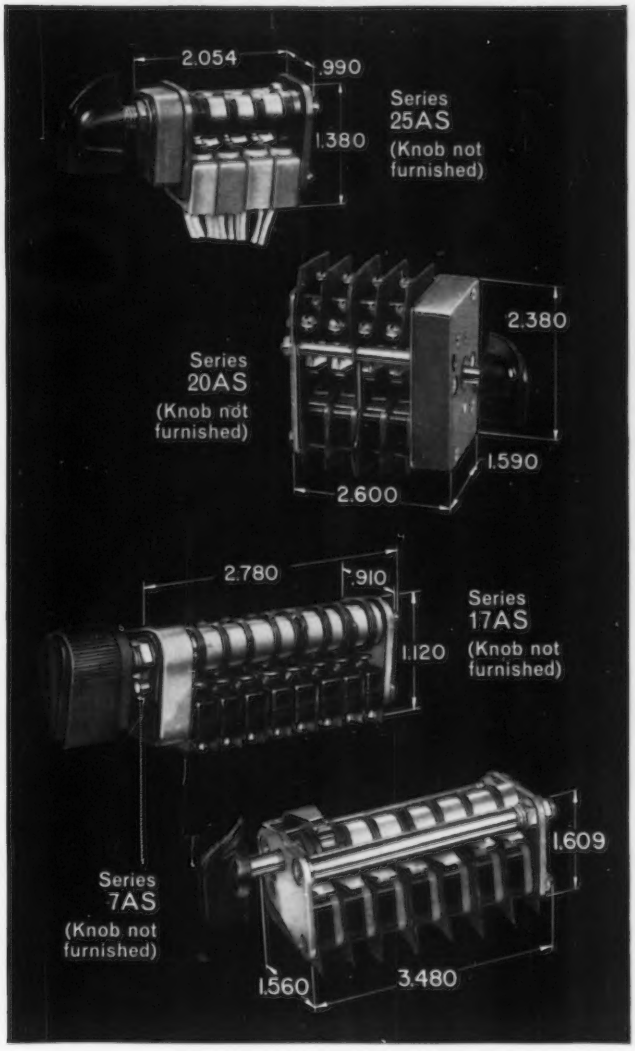
Request Data Sheet No. 133.



53PB8-T2
with 52PA8 Button

Switches have uses unlimited

SWITCH Precision Switches and Aircraft Instrument Panels



Smallest Rotary Selector Switch Assemblies Available . . . Provide up to 20 Switching Units.

"25AS" series rotary selector switch assemblies are the smallest available with environment-proof sealed subminiature basic switching units. Assemblies are available with from two to eight SPDT sealed subminiature switches. Optional positive detent positions from 2 to 8. Rated 5 amps., 125-250 vac. 3 amps., 28 vdc.

"20AS" series rotary selector switch assemblies are extremely versatile. Available with 4 to 20 "V3" type switching units. They are compact, sturdily constructed, and highly reliable. Panel sealing and detent positions are optional. Rated 10 amps., 125-250 vac. 10 amps., 30 vdc.

"17AS" series rotary selector switches are small compact assemblies, available with up to ten SPDT subminiature basic switches. 45 degree angle detents are available in 2 to 8 positions. The use of these assemblies reduces instrument panel space. Rated 5 amps., 125-250 vac. 2½ amps., 30 vdc.

"7AS" series rotary selector switches are compact and sturdy assemblies of two to eight SPDT "V3" type switches, ideal for applications requiring multi-circuit control of 10 amp. circuits. Available in 2 to 8 detent positions. Rated 10 amps., 125-250 vac. 10 amps., 30 vdc.

For complete details on these assemblies ask for Data Sheet 86a.

The two-word name "MICRO SWITCH" is NOT a generic term. It is the name of a division of Minneapolis-Honeywell Regulator Company.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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First in Precision Switching

. . . Your best motor investment is Century

Problems in motor application? Solve 'em right here!

The best testimonial to Century's broad range of motor types and sizes, and skillful application engineering is this: Customers stay with us. Order after order. Year after year.

That points to one thing: Equipment Manufacturers and users make money through Century motor performance, long life, dependability. That's one of the reasons for Century growth and present capacity, typified by the modern St. Louis headquarters plant shown here.

Century motors, from 1/20 to 400 HP, cost you no more, yet give you a lot more. Want to talk about it from *your* viewpoint? Call your local Century man or Authorized Century Distributor.

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MOTORS

CENTURY ELECTRIC COMPANY

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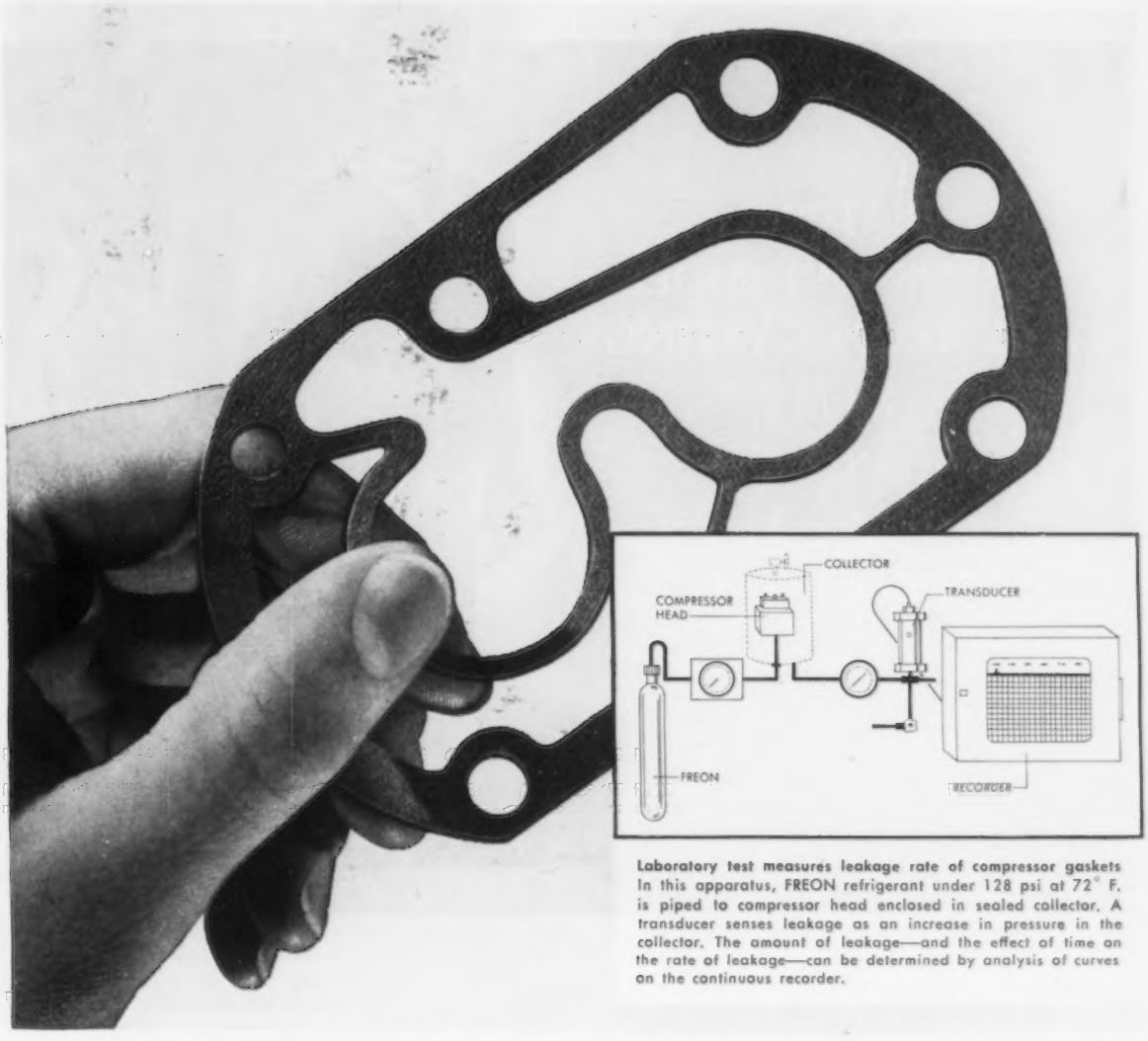


Laboratory test measures leakage rate of compressor gaskets In this apparatus, FREON refrigerant under 128 psi at 72° F. is piped to compressor head enclosed in sealed collector. A transducer senses leakage as an increase in pressure in the collector. The amount of leakage—and the effect of time on the rate of leakage—can be determined by analysis of curves on the continuous recorder.

Seal FREON* refrigerants at lower cost with new asbestos Accopac AN-890

Compressor manufacturers can now get more efficient sealing of FREON refrigerants with Accopac AN-890, a new asbestos gasket material developed by Armstrong research. And this new Armstrong product costs considerably less than conventional asbestos materials now used in such applications.

Accopac AN-890 is made by a beater-saturated process pioneered and patented by Armstrong. This method refines the asbestos fibers and eliminates all lumps and bunches. The result is a homogeneous sheet that is tough and flexible. It die-cuts cleanly to the complex shapes often required by compressor designs.

The binder in Accopac AN-890 is a nitrile-type rubber latex. It reacts to the FREON atmosphere by swelling, and in the confined flange, this swelling actually improves the sealing efficiency of the material.

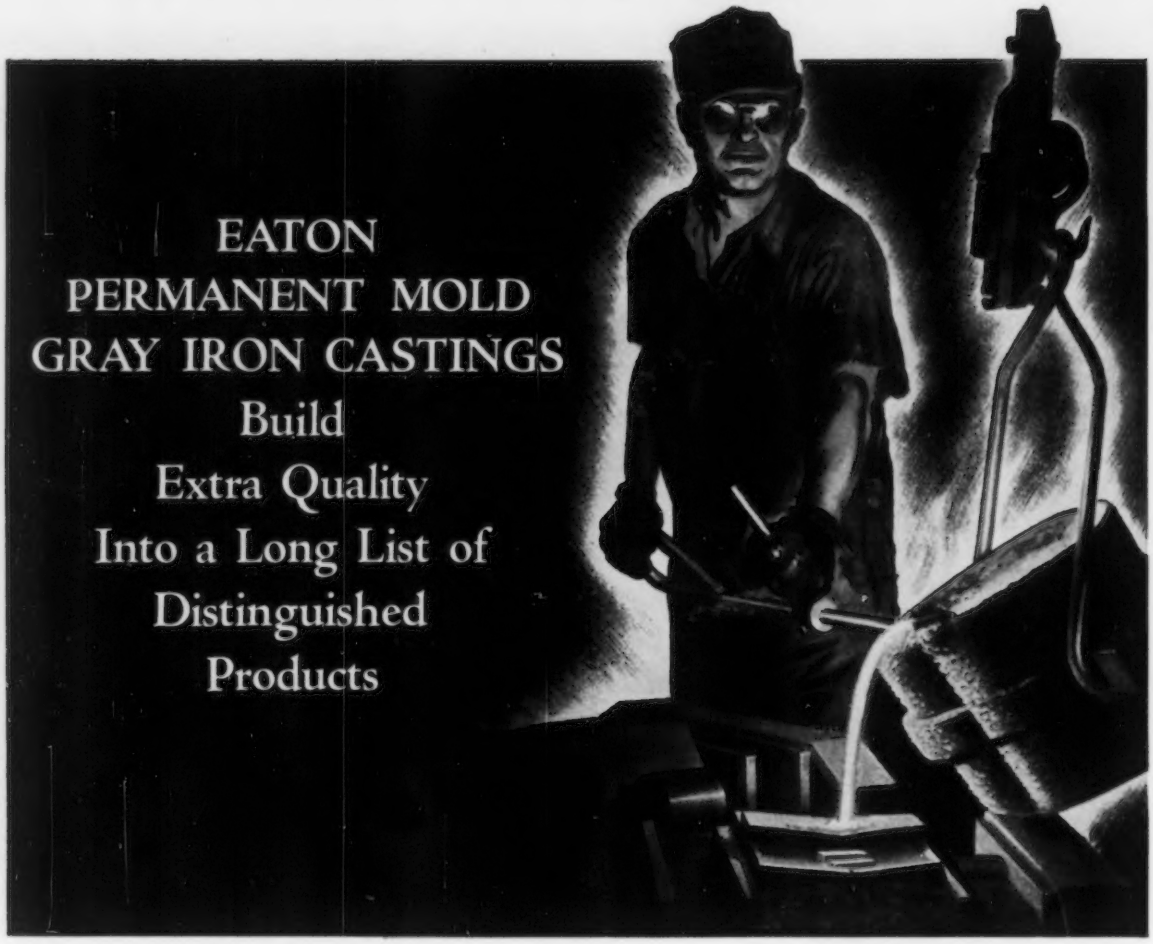
Another important advantage of AN-890 is that it maintains adequate bolt torque when tested in the presence of FREON refrigerants at temperatures commonly developed in compressors.

Accopac AN-890 is available in rolls, sheets, ribbons, or die-cut pieces. For more information and descriptive literature about this and other Accopac beater-saturated gasket materials, write Armstrong Cork Company, Industrial Division, 7004 Irvin St., Lancaster, Pa.

*FREON AND COMBINATIONS OF FREON- AND F- WITH NUMERALS ARE REGISTERED TRADE-MARKS OF THE E. I. DU PONT DE NEMOURS & CO., INC., FOR ITS FLUORINATED HYDROCARBON REFRIGERANTS.

Armstrong ACCOPAC

... used wherever performance counts



Leading manufacturers in practically every major industry have found that the superior structure of Eaton Permanent Mold Gray Iron Castings contribute many worthwhile benefits, not only in the ultimate quality of the finished product, but in manufacturing economies. This is especially true in such fields as motor cars and trucks, refrigeration, air conditioning, domestic appliances, and hydraulic equipment—wherever a dense, non-porous, leakproof structure is a critical requirement. Eaton's advanced production methods, combined with the latest in foundry facilities, assure uniformly high quality and the capacity to deliver on schedule.

Engineers of the Eaton Foundry Division have assisted many of our customers in casting design and process development. Whatever your requirements, our engineers will be pleased to work with you. Why not discuss the advantages of Eaton Permanent Mold Gray Iron Castings applied to your product? Just write or phone—there's no obligation.

Check these Important Advantages:

- ★ **Dense, non-porous, homogeneous structure**
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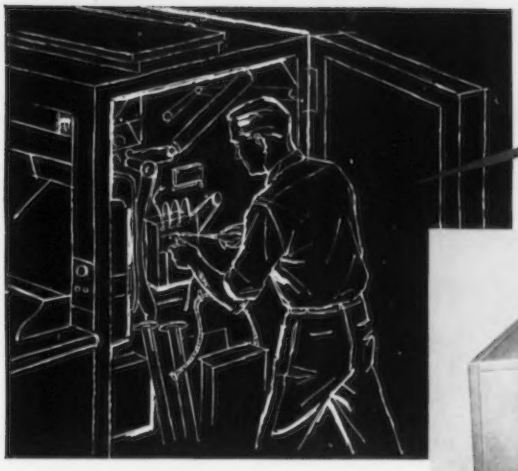
- ★ **Excellent tensile strength**
- ★ **Ability to take a high surface finish**
- ★ **Freedom from leakage under pressure**
- ★ **Intricately cored sections**
- ★ **Uniformity of castings**
- ★ **Higher machining feeds and speeds**
- ★ **Substantially increased tool life**

Send for Illustrated Descriptive Literature

EATON MANUFACTURING COMPANY
FOUNDRY DIVISION
VASSAR, MICHIGAN



—upkeep?

or Keep Up!—

Model 35. Moderately priced machine for volume reproduction. Provides up to 30 f.p.m. speed and full 46-inch printing width.

WHY put up with upkeep, downtime, and aggravations of older reproduction equipment? You can *keep up* the efficiency of your drafting department—and be money ahead—by replacing older units with new, modern Copyflex machines.

Take a moment to compare the performance of your equipment with these modern reproduction advantages. Can you really afford *not* to keep up with Copyflex?

More Operator Conveniences. Modern Copyflex gives printing widths up to 54" to simplify feeding of large tracings, facilitate multiple feedings. Extra-large delivery trays, automatic separation, automatic stacking, and front-or-rear delivery further speed operator's work.

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VT Variable Transformers
Continuously adjustable auto-transformers. Unique Ohmite features for reliable service.

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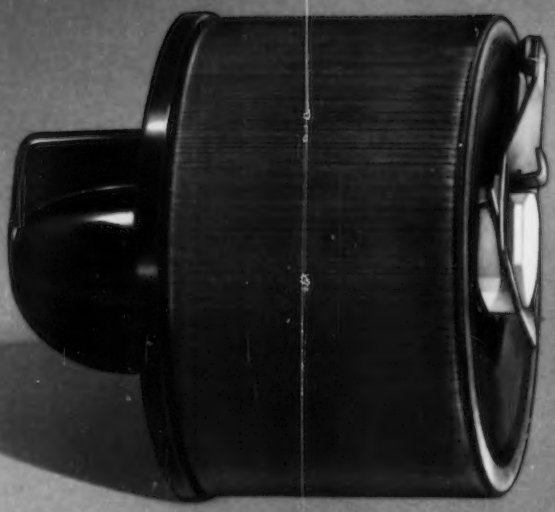
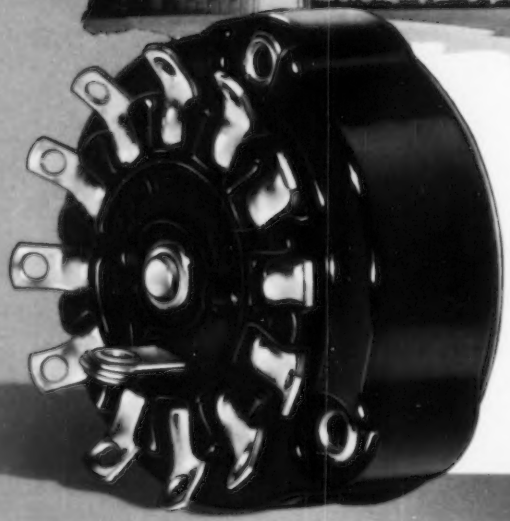
Compact relays in many types. For AC or DC. Power-handling and multiple circuit varieties.



The main ultramodern Ohmite plant contains 170,000 square feet and is one of the largest completely air conditioned plants in the Midwest. Manufacturing areas, laboratories, warehousing, and offices are housed in one efficiently integrated design, thus keeping all phases of production under direct control for service and quality.



Tap Switches
Ceramic insulated selector switches in many sizes for AC use up to 100 amperes. Single or tandem.

Resistors
Vitreous enameled power resistors in tremendous variety of types and sizes.

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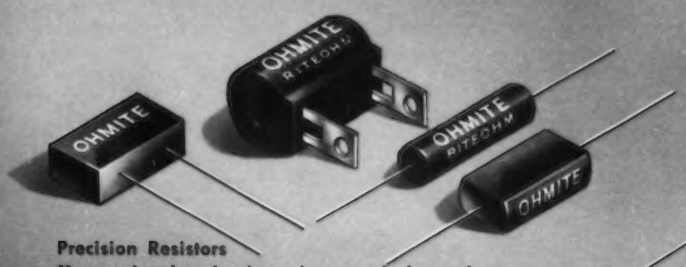
R. F. Chokes
Radio-frequency chokes in many sizes for 3 to 520 megacycle applications. Single-layer wound.



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Encapsulated and other wire-wound close tolerance resistors. Unique Ohmite Metal Film precision resistors.

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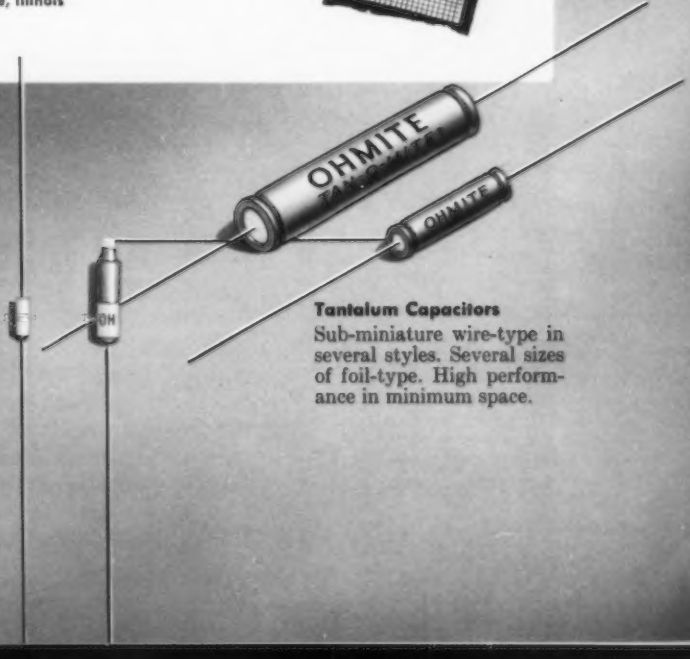
Here it is . . . The new, complete Ohmite Catalog 58! Contains detailed information on Ohmite Resistors, Rheostats, Relays, Tap Switches, Tantalum Capacitors, Variable Transformers, and R. F. Chokes. There are 190 pages of useful tables of ratings, graphs, dimensional drawings, illustrations, and engineering data. Catalog 58 is more than twice as large as the previous catalog. The wealth of information it contains will make it an authoritative reference in the electrical and electronic industries, and a valuable addition to your technical files.

Write on company letterhead for *your personalized* copy.

OHMITE MANUFACTURING COMPANY
3637 Howard Street, Skokie, Illinois

Rheostats
Complete range of vitreous-enameled close control power rheostat-potentiometers. Single or tandem. Many additional features.



Tantalum Capacitors
Sub-miniature wire-type in several styles. Several sizes of foil-type. High performance in minimum space.

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Select proper bolt diameter

An erroneous rule of thumb worth forgetting is that no bolt under ⅝" should be used where fastened members are under stress. Yet bolts ½-inch and smaller take plenty of external loading.

HOW TO LOOK AT IT

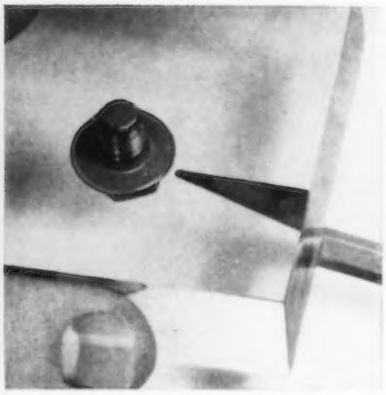
Primarily, you have to satisfy the stress requirements . . . the load. So select bolts on that same basis: the actual strength to sustain that load.

Calculating the strength requirements will tell you what bolt tensile, size, and number you need. If smaller bolts suffice, use them to avoid the penalty of overdesign. Holes can be smaller which means faster drilling and tapping. You have a chance to save materials since with smaller bolt holes, fastened members can often be made smaller too. You may also be able to standardize on a single size, saving assembly-line time.

SIZE VS. SAFETY

Remember that for a given grade of material, size tells you *capacity* of a bolt, not its *safety*. If you *tighten* a bolt to capacity, then you get safety. That's why a smaller bolt properly tightened is better and safer than a larger bolt sloppily tightened, especially where the loads are dynamic. Obviously, you reduce risk of under-torqued bolts as you reduce their size.

The new RB&W "SPIN SEAL" fasteners have spring-type washer with adhering flow-in seal . . . preassembled to standard machine or tapping screw.



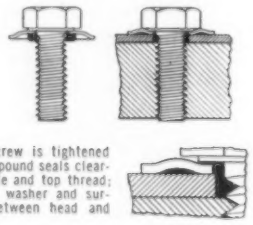
Flow-in sealant is confined by washer. Note how seal fills space under head and flows around and into threads in tightened SPIN-SEAL screw.

New SPIN-SEAL* screws give leakproof fastening

Here is a new type of composite fastener that seals by means of a unique flow-in sealant and washer.

ASSURES TRIPLE SEAL

Concave in shape, the heat treated springy washer confines and controls the flow of sealing compound. Tightening the screw forces sealant into various spaces around (1) threads, (2) head and (3) clearance hole to give hermetic sealing.



When screw is tightened the compound seals clearance hole and top thread; between washer and surface; between head and washer.

The washer has ability to conform to curved surfaces and still seal securely against hydrostatic pressures and wind driven water. Its spring tension and flat rim give the added advantage of dynamic metal to metal seal.

ONLY THE SCREW TURNS

Washer does not turn with the screw. This prevents twisting or tearing the sealing "gasket", marring of polished surfaces, or gouging of painted finishes.

The flow-in gasketing compound is plastic rather than elastic. Stable and non aging, it won't split or ozone-check under pressure. It gives controlled flow into clearance spaces. Compounds are available to seal out water or oil.

Send for Bulletin SS-1 which gives details on RB&W "SPIN-SEAL" fasteners. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y. * T.M.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

PERSPECTIVES

in design and development . . .

The Watch Industry: Time Is Running Out

The domestic watch companies have received a pair of jolting blows to their self-confidence. In a recent decision by the Office of Defense Mobilization, the industry was declared to be no longer covered by the "essential to national defense" clause in Section 7 of the Trade Agreements Extension Act of 1955. It is under this provision that a number of industries, besides the watch industry, have sought tariff protection. The ODM decision was a partial closing of the door on the industry's request for a guaranteed market in the form of import quotas placed on all foreign-made watches.

But the real slap came during the final investigation by the Department of Defense of the missile industry and its dependency upon the horological industry for precision work. Missile manufacturers said bluntly that precision of the missile systems frequently exceeded the capability of the jeweled watch industry.

Precedent for Others?

ODM's decision was perhaps the most important made to date under the controversial "defense essentiality" clause. The fact that the decision went against the watch industry reflects the tougher attitude which the Administration has been taking recently towards protectionists in the developing fight over renewal of the trade agreements act. Earlier, in a number of trade policy actions, the Administration apparently was trying to mollify the opposition. But recently the line has toughened.

The "defense essentiality" provision so far hasn't proved to be a useful device for domestic industries seeking more protection from imports. The President has not used his powers to restrict imports under Section 7 in any important case to date. The most controversial case under this section is still pending, however, with independent oil producers pressing for quotas on oil imports. After two years of striving to obtain effective voluntary import controls, the Administration now seems to be leaning towards a mandatory quota system in an attempt to head off a drive on Capital Hill for legislated quotas.

The decision on watches is the latest in a long seesaw fight by the industry for more protection. In 1952, President Truman turned down a Tariff Commission recommendation for higher duties on jeweled and pin lever watches. Two years later, President Eisenhower granted a 50% tariff increase, following findings by an interdepartmental committee—in which the Defense Department did not concur—that the industry was essential to defense. The duty boost raised a storm of criticism abroad. Now, the domestic industry can either appeal to the Tariff Commission for a further tariff increase under the "escape clause" of the trade act, or seek direct Congressional action.

Times Have Changed

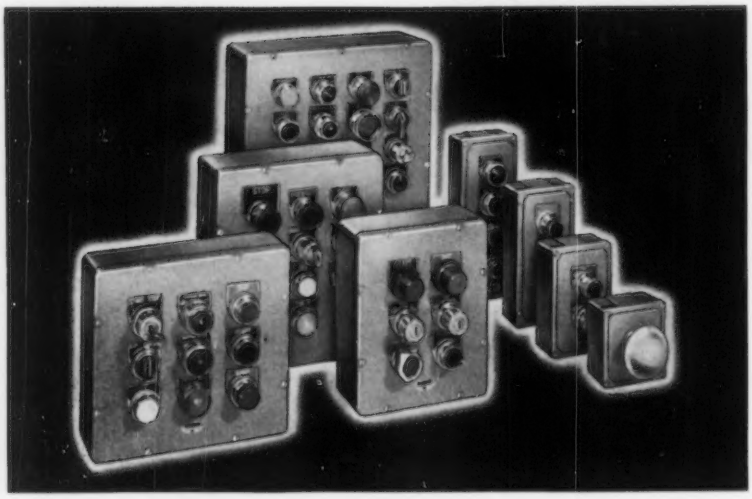
Offering added proof to substantiate the charge that the domestic watchmakers need a shot in their R & D arm, the survey of missile manufacturers also showed: The jeweled watch industry has not been aggressive enough in getting business; the defense items involved depend upon a different know-how and therefore represent diversification by the jeweled watch firms as much as it did for their rivals; and there are millions of dollars' worth of procurement which the industry could get if it would

(Continued on page 49)

The Panelbuilder

66 YEARS OF SERVICE
CUTLER-HAMMER
MOTOR CONTROL
C-H

News for and about Panelbuilders



NEW OIL-TIGHT CONTROL STATIONS PERMIT BASE OR COVER MOUNTING OF CONTROL UNITS

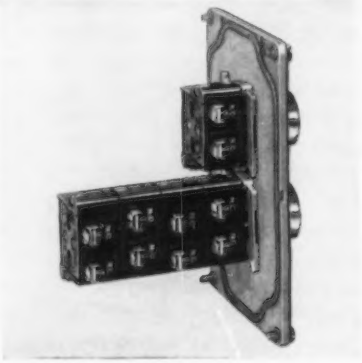
To meet the growing demand for greater flexibility in the assembly of oil-tight control stations, Cutler-Hammer developed a new line of precision die-cast enclosures. These new Cutler-Hammer Control Stations are unique in the fact that they will accommodate either cover or base mounted control units with equal facility. Many have shown a preference for these new control stations because a base mounted push-button, indicating light, etc. eliminates the necessity for hinged wiring.

One to Sixteen Unit Control Stations

Matching Cutler-Hammer Oil-Tight Control Stations are available in eight sizes, the largest will hold sixteen control units. The hinged covers on the six, nine, twelve, and sixteen unit enclosures are snap removable for added working-room during assembly and alterations. The one to four unit enclosures are available in either the normal depth or exclusive shallow depth for use where space limitations are critical. The shallow depth enclosure is only 2⅜" deep and will accommodate one double contact block for each control unit. All normal depth enclosures, including sizes six and nine, permit a maximum of four circuits per control unit; while the twelve and sixteen unit enclosure provides six circuits per control unit.

Oil-Tight Cavity Mounting Cover Plates

Cutler-Hammer also has available a complete line of oil-tight cover plates for cavity mounted control stations. Machine designers and panelbuilders have shown a marked preference for Cutler-Hammer Oil-Tight Control



Units for cavity mounting because one double circuit contact block takes 40% less space behind the panel than the next smaller unit. Also additional contact blocks are easily tandem mounted providing as many as eight separate circuits in any combination of normally open or normally closed contacts.

C-H Master Design

For further information about these versatile oil-tight control stations and heavy-duty pushbuttons and control units, write today on your company letterhead for the illustrated booklet, EL-178, C-H Master Design. CUTLER-HAMMER Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin.

NEW TRANSISTORIZED RELAY COMBINES FINE-SENSITIVITY WITH HEAVY-DUTY CONSTRUCTION

Many panelbuilders have found this new Cutler-Hammer Transistorized Relay to be particularly useful whenever their control problems call for an A-c relay which will respond to either an A-c or D-c signal between .002 and .02 amperes. The heart of this compact relay is the plug-in type signal amplifying module which contains all the electronic parts. This tough module is practically indestructible, and the plug-in design insures rapid maintenance . . . cuts downtime to a minimum. The Bulletin 13535 transistorized relay requires no warm up time and it is exceptionally quick in operation. Relay is rated at 10 amperes, 110 volts and the price is unusually low. Cutler-Hammer also offers conductive liquid level probes, and photo-cell units for use with the transistorized relay. For further information, write today for Bulletin 13535.

improve its engineering sales techniques. It was shown that from 1951 to mid-1957 only $8.6 million of subcontract work was done by the four jeweled-watch manufacturers for all manufacturers of military equipment. Every missile firm said that it had good sources of supply completely outside of the horological industry for every item that the jeweled watch industry listed itself particularly qualified to produce.

Changed Military Concept

Defense Department studies also indicate that new-type weapons and changed concepts have reduced current mobilization needs for jeweled timing devices. As of December 1956, for example, military requirements for jeweled watch and chronometers were greatly reduced from World War II needs, and down to about one half of the 1954 estimated requirements. Since the 1956 estimates, military requirements for watches and clocks have dropped slightly; the same period has seen a 75% reduction in those timing devices which had been major horological-industry sales items to the military. In a survey of 37 non-horological firms, it was shown that, without disturbing their production of other military hardware, their ability and capacity to design and manufacture horological items was far in excess of the volume of orders given horological firms.

Concerning R & D, the Assistant Secretary for Research and Engineering found that while the watch industry deserved credit it did not appear to have any unusual capability that could not be found elsewhere. Paul D. Foote, an Assistant Secretary of Defense, said that "most of the development work was the adaptation of watch mechanisms to supply a time function for such items as fuses, etc. In other words, most of this work is aimed at product engineering." He added, "We observe no highly significant or promising research that would support the idea that the industry is, because of its special techniques, essential to the security of the United States. In fact, most of the production machinery was either purchased from the Swiss, or was adaptations of copies of Swiss machinery."

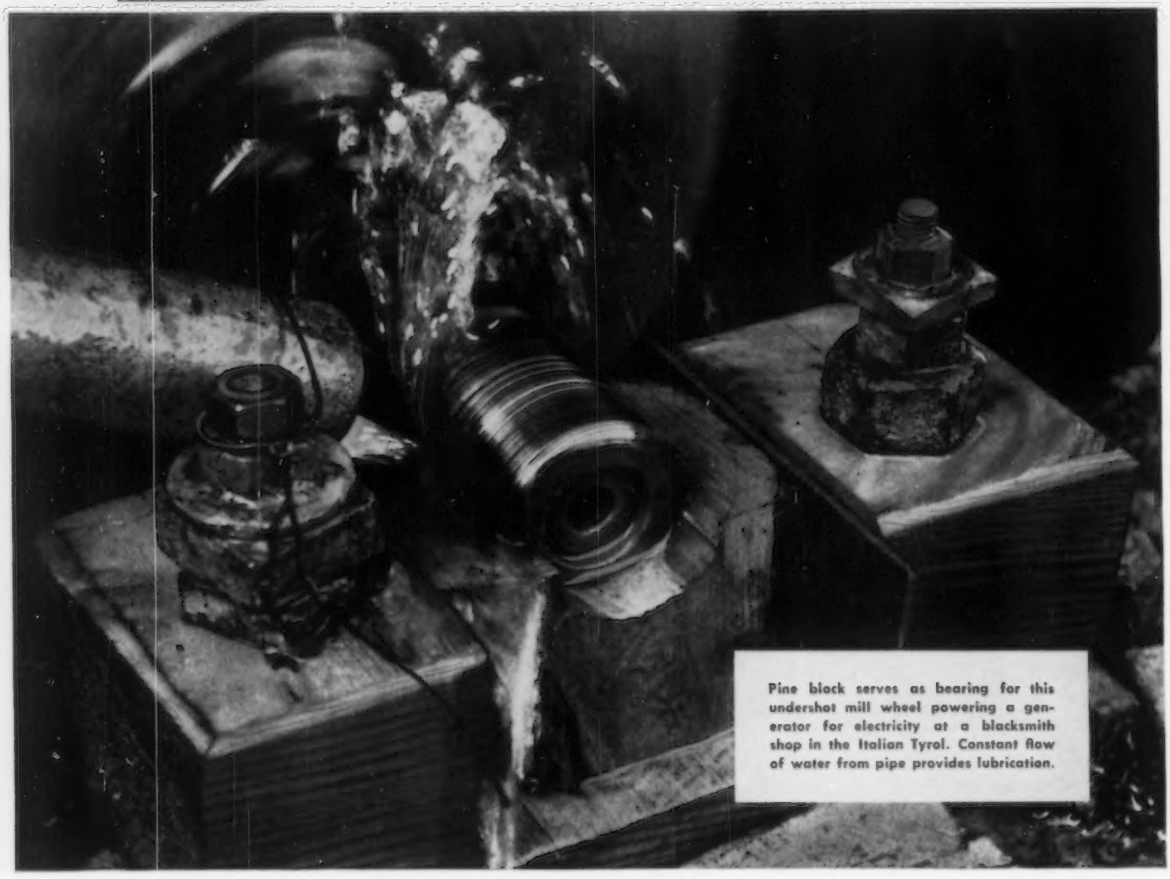
Other Industries Have Same Labor Skills

Parallel with the Defense Department study was one by the Department of Labor—to determine the special skills of the watch industry and its manpower requirements during mobilization. This examination covered nine key skills agreed upon by the jeweled-lever industry as being representative of its importance. Skills in a number of pin-lever and non-horological precision plants also were checked to see if similar skills existed in these plants, and how long it would take for a person to become proficient if transferred from one group to the other. This study showed ". . . there is a strong presumption that most, if not all, jeweled-lever watch industry skills can be developed within three months from the similar skills found in pin-lever watch manufacture." (Jeweled watches differ from pin-lever watches principally in using jewel bearings in the escapement mechanism. The pin-lever watches use hardened steel pins and bearings in place of jewels). Also, ". . . with training periods of varying lengths there could be some interchangeability between precision manufacturers outside the horological industry." And, ". . . the skilled occupations which are most 'unique' to the jeweled-lever watch industry are those for which, based on estimated mobilization needs, there could be least mobilization requirements . . ."

It was found that in jobs considered counterparts to the nine key skills of the jeweled-watch industry, the non-horological people use the same methods and techniques, need comparable tools and machines; and work to comparable tolerances.

—Paul Anderson

ND FACTS



Pine block serves as bearing for this undershot mill wheel powering a generator for electricity at a blacksmith shop in the Italian Tyrol. Constant flow of water from pipe provides lubrication.

Is pillow block inefficiency costing your plant money?

The need for relubrication of pillow blocks is *more* than costly today! It's *passé*. For New Departure's new pillow block line is built around the performance-proved Type AE adapter ball bearing with *Sentri-Seals*. Dirt, moisture and wear are sealed *out* . . . grease is sealed *in — for life!* Send for details about New Departure pillow blocks. Ask today for Catalog PBC-A.

These bearings are quickly and easily applied to shafting without special tools. They are positively locked in position with eccentric cam locking collar and set screw.

1908–1958 GM FORWARD FROM FIFTY

ND NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Product Engineering

April 14, 1958

WHEN THE minority RULES WELL

You know the old story of the Negro poker game in which one player held three kings, another a full house, but the winner had two nines . . . and a razor. That's once when the minority rules.

Or consider the Budapest String Quartet, a rather famous long-hair musical group of Russians in the United States. These four men have very different interests outside their music—and sometimes within it. Generally speaking, they select new numbers by majority—unless the minority (in this case only one man) has a decided objection. Or they may prefer to rehearse at a given time or place, but again a single member may wish to change either time or place for some special reason. If the others are not too badly inconvenienced, they shift to suit him.

This is *not* rule by the majority, but it is common sense. It keeps the quartet together on the job.

There are other cases in which it is prudent or sensible for the minority to rule, despite the well-known tenet of freedom that the majority has the say. Viewed objectively, the majority has nothing in its favor but numbers.

From a practical standpoint, rule by majority seldom occurs anywhere except in open meetings—and even these are usually heavily influenced by personal considerations. We gave up majority rule in elections long since in favor of the two-party system—and in many areas, we actually have only one party.

In industry, majority rule is negligible. In most companies, the boss carries the "razor", or his favorite carries it for him. Even in committees, there is usually some form of razor sticking out of somebody's hip pocket. When the razor is a technical one—based on superior knowledge—it may be a good influence. But often it is merely persistence that wins out over the lethargy and distinterest of other members. Then it can be a bad influence.

The ideal is honest rule by the interested majority. But this must always be tempered by the understanding that one man may have special knowledge, or special abilities that make his opinion worth extra votes in the tally. Or if the minority has sound reasons for its opinion, and the majority merely inclinations or preferences, then again the minority should rule.

The most important contribution of democracy is still that the minority should be heard.

ATOMIC ENERGY: THE FACTS

We've come a long way since Hiroshima; but nowhere near as far as we'd like to believe. Here's where we stand on nuclear applications, and how we can step up future progress.

ANNESTA R. GARDNER
Associate Editor

We are a nation of optimists and enthusiasts, with a love of action and a reputation for practicality. But, too often, our optimism turns to daydreams and our enthusiasms are short-lived.

Back in 1945, when the smoke cleared above Hiroshima, we promised ourselves great new benefits from atomic energy: cheap, abundant power . . . planes that would fly round the world without refueling . . . submarines that could sail the seven seas for years . . . brand-new ways to process materials and produce new products. We promised—and we set to work. But can we be proud of our rate of accomplishment? Are we going as fast as we hoped and planned? Or are we in danger of getting sidetracked—by new enthusiasms and new fears? Let's see where we are and where we seem to be going in power, planes, ships, and processing.

ENERGY FOR ELECTRICITY

We are today operating six power-type reactors, including the Vallecitos reactor pictured on the cover. Four of these can feed, have fed, or are feeding power into commercial lines. **But of these reactors only one is commercial-size—and we won't have another before 1960.** (Vallecitos is our first privately financed one, and it's feeding power into commercial lines; but it's not commercial size. Output is only 6500 kw.)

The commercial-size operating unit—Pittsburgh's Shippingport reactor—is rated at 60,000 kw. But these are "24-carat" kilowatts. Present cost is well over 52 mills/kw-hr. This will come down, the builders say—perhaps 30% in the next 3 years; and another 30% three years after that. When will this reach the competitive level of 7 to 8 mills? **Probably never. It was never expected to.**

The Shippingport reactor was conceived and built as a big laboratory—one of a series of reactor types, all experimental—to provide operating data on which to base design of future plants. There was no immediate economic incentive for atomic plants in this country, and it seemed a good idea to try as many different types as possible while we still had the time. We had—and have—plenty of conventional fuel. Even now, AEC estimates do not envision A-power costs dropping into the coal-plant range before 1975.

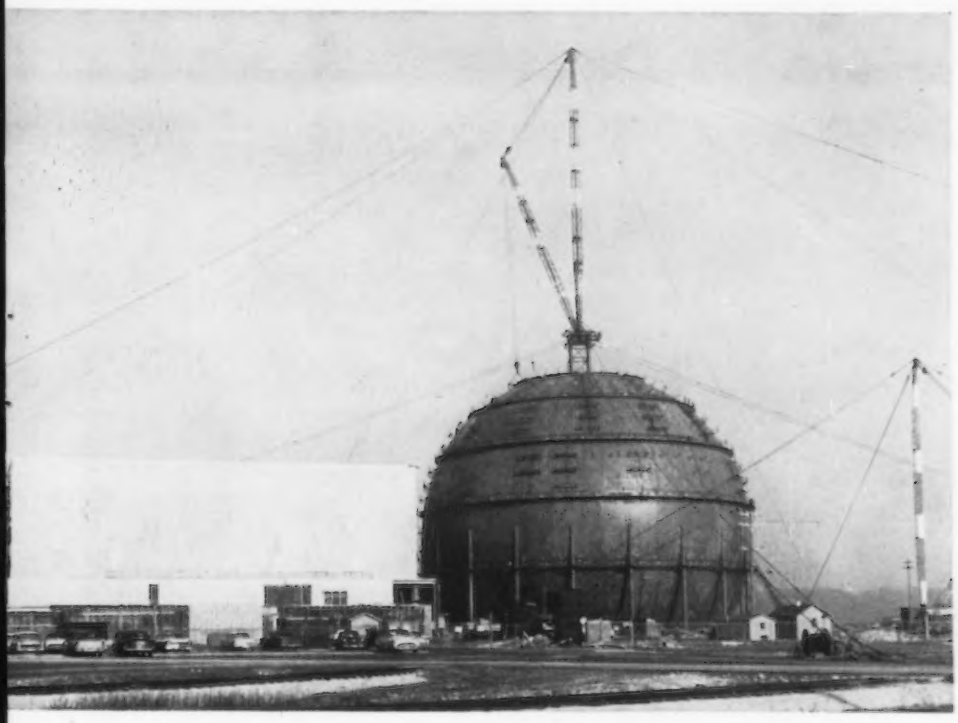
Nevertheless several forward-looking utilities are building their own reactors. These plants are commercial-size. But neither they nor their builders expect to make money on them. Commonwealth Edison's Dresden plant, for instance, was originally estimated to cost $45 to $60 million. The lower figure would mean $250/kw of installed capacity—already well above the average cost of steam plants being built today; and even the upper figure looks conservative.

The Question Marks

Estimating for unbuilt plants is a tricky business at best. With nuclear plants, it is trickiness compounded. There are all sorts of new factors to contend with: fuel-element fabrication, burn-up, fuel reprocessing. These problems have no counterpart in coal-fired plants, and there is little precedent to go on. Small wonder then that cost estimates range all over the lot.

Originally, it was hoped power could be produced for about 8 mills/kw-hr. This would be within the current range for steam plants (5 to 10 mills/kw-hr). Now, though, estimates range upward from 13 mills. Of this, 2 to 6 mills are fuel cost. Here, the lower figure is within the range for conventional plants (the national average is about 2.7); but the higher figure now seems more realistic.

Biggest question mark is the cost of fuel. There are



Dresden Plant . . . of Commonwealth Edison will be the first truly commercial nuclear plant for the generation of electrical power. It's scheduled for completion in 1960, with rated output of 180,000 kw. Steel sphere will contain reactor.

many problems here, ranging all the way from refining to waste disposal. For instance, in the conventional plant, the fuel—or most of it—is burned, the ashes are emptied out, and new fuel is added. Not so with a nuclear plant. Only a small fraction of the fuel can be "burned" before the "ashes" (fission-breakdown products) start interfering with the reaction. The fuel must then be removed, reprocessed, and reinstalled. This means the percent of burn-up before reprocessing, and the cost of reprocessing, are major factors in fuel cost. Both are the subject of intensive research, and progress is being made, **but the difference between present performance and future projections is still more than enough to turn profit into loss.**

Of course, as noted above, present-day plants were not expected to be competitive; they may have advantages aside from cost. W. K. Davis and W. H. Roddis, Jr., of the AEC put it this way. A company considering a new power plant might select a nuclear plant "as a hedge against the possibility of unusually large future increases in conventional fuel costs," even though, right now, comparison of costs over the full life of the plant might seem to favor the conventional design. "It seems inevitable," they say, "that nuclear fuel costs will decrease over the next 30 years, while conventional fuel costs seem likely to increase."

But whether nuclear plants are more or less expensive, this is certain—the promise of limitless, cheap power from the atom is vastly overrated. The fact is, 85% of the cost of power today is in distribution. There is also an item of cost in generation. The atomic reactor—as of now—is just a boiler, a source of heat to produce steam or superheated, pressurized water; as such it substitutes for only one part of an electrical plant. Furthermore, the atomic-energy program is today the largest single consumer of electricity; and it is not expected to become a net producer for many years.

As for thermonuclear power—fusion reaction of the "tamed" H-bomb—even the enthusiastic US-British announcement last January admitted that no major breakthrough had been scored. Barring such, fusion-power plants are far beyond the horizon (*PE*—Oct. 21, '57, p. 12, *and* Nov. 24, '57, p. 12). Even with a breakthrough, it would take many years to find the best way to put fusion energy to work, design and build prototype plants, and secure needed operating data. The first demonstration of fission power came in 1942—and that was controlled power. **The first controlled, net-gain fusion reaction (producing more power than needed to make it take place) has yet to be achieved.**

ENERGY FOR THE AIR AGE

Some eight years ago, an AEC spokesman claimed, "Better than 90% of the engineering knowledge necessary to build an atomic airplane is now on hand." He was probably right then—and now. Trouble is, the other 10% is still missing—and so are the special shielding and construction materials essential to hold a reactor down to liftable size. (This shielding problem is even more acute when it comes to atomic locomotives, and puts reactor-powered autos out of the picture.)

Today, solution of these problems looks so distant that atomic energy authorities both here and abroad have put the A-plane on the back burner. (Until the recent flurry of Sputnik-type excitement, the AEC

First production model A-sub . . .

the Skate, is now undergoing sea trials. Built by General Dynamics, it features dual controls (right), and many advanced design systems.

planned to spend $3.5 million less on its aircraft nuclear propulsion activities this year than it did last.)

British Minister of Supply Aubrey Jones feels formidable problems are apparent in development of nuclear-powered aircraft—problems in the field of fundamental research: "Until we can be satisfied about the future line of development . . . great expenditure is not considered justifiable."

Yet J. Carlton Ward, president of Vitro Corp., says, "We could have had a nuclear-powered plane flying today if we had kept at the ANP (Aircraft Nuclear Propulsion) project as it was first laid out in 1946." **And our Navy still thinks it can have a nuclear plane in the air in less than three years.** If that estimate is correct, it should certainly be possible to build an atomic-powered rocket in the near future. Here, the shielding problem would not be so acute. It might, in fact, be possible to design a nuclear reactor that would leave its shielding on the launching pad and emerge slim and sleek as a firing pin for its journey through space.

In mid-February, the Air Force ordered design work on an atomic rocket to begin, and AEC chairman Lewis Strauss has admitted that it should be possible to produce one "in about three years." But members of the Joint Committee on Atomic Energy think we should have one now. They charge that "the history of Project Rover (the nuclear rocket program) has been filled with delays and monetary cutbacks."

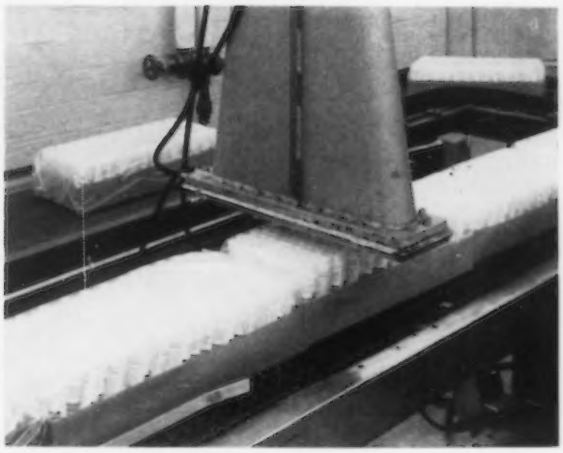
ENERGY FOR NUCLEAR SHIPS

If we can't have an atomic plane right away, we can at least point with pride to our atomic submarines. We have one reactor-powered submarine in full operation, and three more (one "experimental" and two "production models") now on the way. (The *Skate*, pictured above, is first of the "production models.") Half a dozen are under construction, and a dozen more authorized. The keel has been laid for an atomic cruiser, and work is expected to start on a merchant ship next month. An atomic carrier has also been authorized, though its future was in doubt for some time.

The Navy program has been one of the brightest spots in the whole atomic-energy picture. It laid the basis for much of our present civilian reactor program. But it had to struggle against tremendous odds, and still has to much of the time. For instance, Senator Jackson, of the Joint Committee on Atomic Energy, has proposed that we immediately start building a fleet of large nuclear-powered submarines, "underwater satellites," capable of launching intercontinental missiles. There seem to be no insurmountable technical problems in this area. But no concrete action seems to have been taken thus far.

ENERGY FOR RADIATION PROCESSING

If the atomic power programs elsewhere leave something to be feared and much to be desired, the industrial picture, at least, has many bright spots. Great progress has been made with radioactive isotopes—byproducts of nuclear reactors. As tracers, radioisotopes are helping us study the alloying and fabrication of metals, polymerization of plastics and vulcanization of rubber; helping us control thickness, measure wear and detect



High-energy machines . . .

generate electron beams for drug sterilization, food processing, experimental work on materials. This 2-MEV Van de Graaff generator, built by High Voltage Engineering Corp., is sterilizing surgical supplies. Generator itself is at left; scanning beam emerges from hood-like unit at right.

flaws. We have radioactive batteries, signaling devices and luminous paints. **But the long-promised commercial use of radioisotopes, waste fission products and reactor-produced neutron beams to create and produce new materials, to sterilize and preserve foods, and to improve the properties of existing materials, is still just a promise.**

Radiation is today improving the properties of plastics and sterilizing medical supplies. But this radiation is not coming from reactors, directly or indirectly. It's coming from machines, machines which could have been built even without an atomic-energy program. True, the atomic-energy effort accelerated their development. But it didn't create them.

The reason why machines are preferred to reactors and reactor byproducts isn't hard to find: The machines are available—and available now—without red tape and at a fixed cost; furthermore, that cost is a lot lower than current prices for isotopes capable of doing similar treatment jobs. The machines are a lot easier to handle than isotopes (machine radiation can be directed, and the machine can be shut off when not in use) and they do their work a lot faster. Radioisotopes are low-power sources (70,000 curies of radiocobalt is theoretically equivalent to 1 kw), and treatment takes a long time. (A curie is a measure of radiation, and is roughly equivalent to the activity of one gram of radium.)

The new linear accelerator installation at Ethicon, Inc. (*PE—Feb.* 10, *p.* 8), is a good example. This is a 7-MEV machine, with output of 4.2 kw, set up to sterilize catgut sutures. Cost of the machine was about $170,000. A comparable cobalt source would be more than 300,000 curies. At an optimistic estimate ($3 a curie), a source of this size would cost close to a million dollars. But that is only the beginning. Shielding and conveyor for the machine cost $50,000-60,000; for the isotope source, the cost is estimated at nearly four times as much because of the special problems raised by the isotope. Because you can't shut an isotope source off, for instance, conveyor design poses special problems. There must be some place to put the isotope while the conveyor is being repaired—and the conveyor itself is likely to be more complex in design.

Even shipping the isotope would pose problems. Shipping cost for a source this size—if one were available, and it is not—would run at least 15¢ a curie: $42,000 or more. (The largest single source so far made for shipment is the one now at the Esso Research laboratories in Linden, N. J. It weighed barely a pound, but had to be encased in a lead cylinder weighing several tons.)

The isotopes do have one advantage over some machines: their penetration is five or six times as great. But this does not now seem to be as great an advantage as was first thought. Installations like the one at Ethicon are getting along very well with the machine's 1¼-in. penetration; and this can be stepped up, if necessary, to a level comparable to that of isotopes by converting the machine to X-ray generation, or by dual bombardment. (This, however, brings a penalty in electrical efficiency.)

Commercial-scale processing, of course, isn't the whole story. **Used for research—in small packages—isotopes have many advantages.** A 1- or 2-curie source is small, easy to handle, easy to shield, and much lower in cost than the smallest commercial electron beam machine. (A 1-MEV van de Graff generator costs about $35,000. The base price for radiocobalt is $2 to $9 a

curie. Even with shipping and shielding charges, it should be possible to get enough for a tracer experiment for no more than $100.)

So, right now, it looks as though large-scale use of isotopes for food and drug sterilization, chemical processing, and materials improvement is a long way in the future.

Meanwhile, the one program aimed at testing large-scale application of atomic energy to food processing has been subjected to repeated delays and changes. This was the Quartermaster Corps plan for setting up an Ionizing Radiation Center. It was to have isotope, machine, and reactor sources, and was scheduled for completion this year. Now the date for operation is late 1960, and plans for the reactor have been all but abandoned.

What Speed Ahead?

Where does all this leave us? Certainly we're on the road. We have made progress—quite a lot in the past dozen years. But do we have a plan for the trip ahead? Are we moving as fast as the traffic will permit? Are we even moving fast enough for safety?

We can find plenty reasons for not moving faster—newness of the field, the need to wait for operating data, dangers of obsolescence if we build too much too soon, potential hazards to life and limb. **But these reasons won't provide much shelter from the blasts—economic or military—likely to face us if we fall too far behind.**

What can we do? Over-all planning, of course, requires government action. But, as individuals, we can encourage the necessary measures; and we can act directly in at least three ways:

(1) by breaking the barriers that still surround nuclear scientists—barriers based on lack of understanding between people in government laboratories and in industry, rather than on security. **These self-imposed idea fences do more to prevent free interchange of information and hold back research than any security rules.**

(2) by encouraging further development of atomic energy through making full use of the atomic byproducts now available. Nuclear batteries with a useful life of 10 years or more can be purchased for as little as $5.50, and nuclear timers are available commercially (*PE—Feb. 10, p. 7*). Isotope paints safer than radium, and competitive in price, are being marketed, as are isotope gages. Several hundred "labeled" compounds are listed by a score of suppliers.

(3) by helping provide the many auxiliary items—valves, pumps, instruments, motors—needed by reactor builders and operators. Many of their requirements could be met by relatively minor modifications of existing products, and it's a good way to get a foot in the door. *Selling to the AEC*, a pamphlet available for 25¢ from the Government Printing Office, covers many product categories; lists of AEC publications in many fields, including patents available for licensing and sale, are obtainable from GPO and the Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

Other publications worth having—these available without charge while supplies last:

101 *Atomic Terms*, Esso Research & Engineering, 15 West 51st St., New York 20.

Nuclear Energy in Britain, Reference Division, British Information Services, 45 Rockefeller Plaza, New York 20.

Power Reactor Systems (GER 1384), General Electric Atomic Power Equipment Department, Schenectady, N. Y.

Moving Ahead with the Atom, Chase Manhattan Bank, 18 Pine St., New York 15.

EDITOR'S NOTE: Earlier articles on design considerations in applying atomic energy:

Energy Sources

"Characteristics of Nuclear Reactors," May '56, p 138, covers major types in power and irradiation of materials; performance characteristics of each type.

"Nuclear Reactors Pose New Problems in Mechanical Designs," Apr '56, p 187; new requirements imposed on materials, components and controls.

Radiation Processing

"New Materials by Irradiation," Apr '57, p 167; how radiation, by changing properties of materials, creates new ones.

"Radioisotopes in Research and Industry," Mid-Oct '55, p A21; roundup of major fields of use as tracers, in instrumentation and processing.

"Radioisotopes as Design Tools," May '55, p 129; properties of eight radioactive materials of special value in engineering testing.

"Investigating Friction and Wear with Radioactive Tracers," Mid-Oct '52, p A10; reports a study on the effect of lubricant-bearing material and metal transfer.

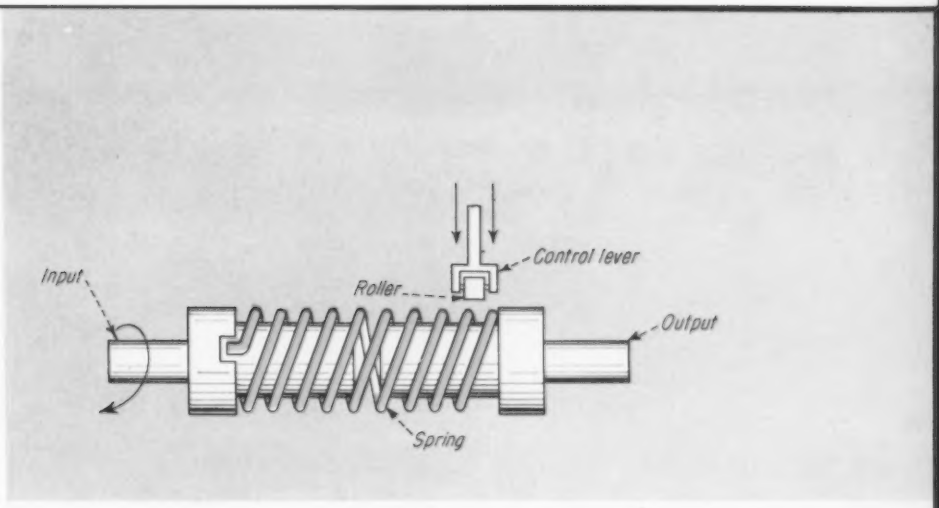
This week
at the DESIGN SHOW . . .

Editors of *Product Engineering* are attending panel sessions and concurrent technical sessions at the Design Conference summarizing contributions of panel members and discussions of papers for the first part of a staff-written report to appear in the April 28 issue.

Every exhibit is being visited by editors looking for new design ideas, new materials and components, new production methods and services to report in the second part of the staff-written show report.

Written by the *Product Engineering* staff as the Design Show closes on April 17, this two-part special report will be printed and on the way to you in less than a week after the show closes.

Watch for this special report in the April 28 issue.



SPRING CLUTCHES for FASTER RESPONSE

Essence of the idea is a helical spring bridging input and output shafts, as illustrated above. Article describes applications and works out an example where spring clutch shows its advantages for high-speed indexing.

EUGENE V. LEONARD,
Vice-president, Engineering
Digitronics Corp.
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Speedy response is the common denominator that distinguishes clutches which employ a helical spring to couple output to input shaft. Such mechanisms can be varied to perform as on-off clutches; as high-speed indexing clutches allowing full, fractional or multiple revolutions; as overriding clutches; or as brakes for almost instantaneous action.

Furthermore, when a trigger mechanism and a solenoid or miniature relay are incorporated in these clutches, result is a true mechanical amplifier analogous to a vacuum tube or transistor (but rated in terms of energizing-to-transmitted torque). The energizing torque here corresponds to control voltage; transmitted torque to output signal. The design permits converting a series of electrical pulses to mechanical movements—a function nicely suited to computer applications.

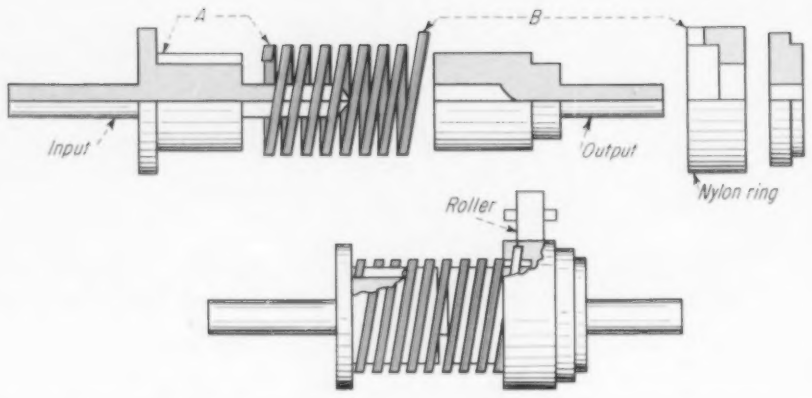
For example, the indexing spring clutch becomes a digital device, responding to numerical information and converting it into exact and repetitive displacements. And the on-off type becomes an analog device. It will respond to an energizing signal and travel through an angle corresponding to duration of the signal.

Compared with electromagnetic clutches, spring types can deliver torque in one direction only (in reverse direction, the clutch overrides), and are somewhat more expensive. However, spring clutches respond much faster to a signal—they can bring a rated load up to full speed in less than 2 millisec (0.002 sec)—and deliver a higher ratio of torque to inertia. In other words, besides being faster acting, they can carry a higher load for their size.

OPERATING PRINCIPLES

Basic unit of a spring clutch is the helical spring that bridges two in-line shafts. The spring usually has a rectangular cross-section and is coupled to the input, rotating with it. Spring dia is larger than dia of the output shaft, so rotates freely around it. In the normally OFF clutch the spring, when pressed by the control lever, begins to twist around the output shaft. This causes tension forces in the spring, and its radial components take a still tighter grip on the shaft—but only as long as the control lever is kept activated.

Releasing the lever permits the spring to return to



Infinitesimal force . . .
less than 0.05 in.-lb against nylon ring, can energize on-off clutch. Spring is attached at A and B; force is applied through roller via linkage (not shown).

its free dia. This disconnects the clutch and the output shaft coasts to a stop. For an instantaneous stop, the output shaft must also be coupled to a brake which is energized simultaneously with the lever release.

In the normally ON type, the lever is spring-loaded to maintain drag on the helical spring. Engagement is continuous until actuation of the lever permits the spring to return to its free diameter. This disconnects the clutch, and the output shaft coasts to a stop.

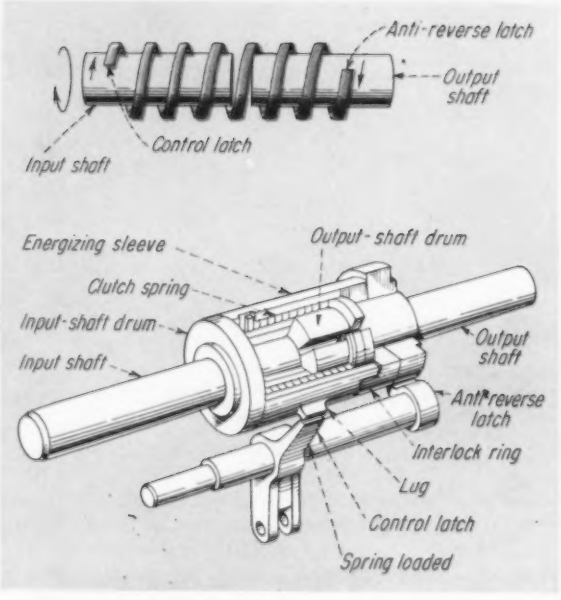
Actually, for practical reasons, a nylon ring is attached to the free end of the helical spring and is the means by which the lever supplies drag to the spring. Spring loading in the normally OFF clutch keeps the lever out of contact with the ring and therefore no drag is applied to the helical spring. In the normally ON clutch, the reverse is true. Spring loading keeps the lever in contact with the ring, maintaining drag.

With either type, applying only a slight torque (0.05 in.-lb) to the control lever gives sufficient drag to activate the spring.

INDEXING CLUTCH

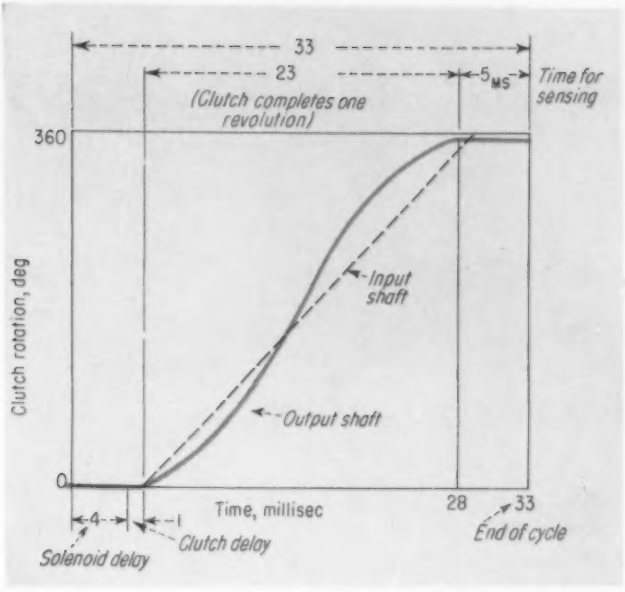
A simplified version of the indexing clutch works like this. In the energized state its spring dia is smaller than both shafts. To de-energize, the control latch at the input end of the spring is released. The spring strikes the latch and begins to unwind. Result is a slight diametral clearance between the spring and shafts —so no torque is transmitted. A slight overtravel lets the anti-reverse latch fall into place. This prevents the spring from backing up and the clutch is now non-operative.

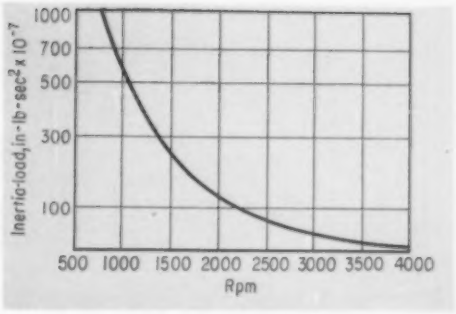
To re-energize, lever action flips out the control latch, and stored energy of the spring causes it to grip the shafts again.



Indexing clutch . . .
in a form supplied by Digitronics, employs tightly wound spring to drive output shaft. Control latch releases spring; anti-reverse latch prevents spring from backing up.

In the type of indexing clutch illustrated here, one end of the spring is attached to the energizing sleeve, the other to the output drum. The control latch intercepts the lug of the energizing sleeve, unwinding the spring. If the sleeve has two lugs 180° apart, the clutch makes a half revolution with each impulse to the release latch. Similarly, for six indexes per revolution there must be six lugs—each lug on the energizing sleeve requires a corresponding lug for the anti-reverse latch. How close lugs can be depends on sleeve dia.





Speed-inertia ratios . . . ▲ for clutches up to 120 oz-in. torque capacity give design recommendations for 25 million cycles.

Indexing cycle . . . for computer tape uses clutch with 5-millisec delay. Lag between output and input shafts is caused by rubber coupling.

HIGH-SPEED INDEXING—AN EXAMPLE

For high-speed indexing, response time often decides choice of clutch. Here is a typical problem which calls for spring clutch with built-in solenoid (a "power pack"). Determine the input-shaft speed:

Computer tape is to be moved from perforation to perforation at the rate of 30 cps. There are 33 millisec available for a full cycle (1/30 = 0.033 sec). In this interval the following operations must be performed: solenoid energization, clutch energization, acceleration and deceleration of the tape mechanism, and sensing the perforations which takes 5 millisec. At end of full cycle, clutch must be ready to receive a repeat impulse.

To handle the inertia of the indexing mechanism, the clutch must be capable of transmitting 108 oz-in. of torque. From the manufacturer's specifications, the following combination clutch and solenoid is selected. (Data for electromagnetic type also included.)

	Spring Clutch	Electromagnetic Clutch
Outside dia	1 in.	1.25 in.
Length	1.656	2 in.
Torque	120 oz-in.	60 oz-in.
Response—clutch	1 millisec	28 millisec
—solenoid	4 millisec	

Therefore, time available for the clutch to complete one revolution in millisec, is:

Total time available	33
Sensing of tape	−5
Clutch delay	−1
Solenoid delay	−4
	23 millisec

To complete a cycle in this time, clutch input speed must be

$$\frac{1}{0.023}(60) = 2600 \text{ rpm}$$

The speed-inertia curve (see above) gives max inertia loads that the clutch can pull when long clutch life is desirable. For 2600 rpm the inertia load should not exceeds 70×10^{-7} in.-lb/sec².

Referring to the electromagnetic clutch, it takes 85% of the available time (23/33) to build up to rated torque. Obviously this clutch cannot complete one revolution in the remaining 5 millisec. An indexing spring clutch does not need special braking methods to stop accurately at each station. So using a power pack reduces the design problem to determining required specifications and make the proper selection.

EDITOR'S NOTE: For design data on other types of clutches see these recent articles:

"Multi-function Overrunning Clutches," Feb 3 '58, p 78. Illustrates types that do more than one job to reduce space and costs. "10 Ways to Apply Overrunning Clutches," Nov 25 '57, p 118. Shows how overrunning clutches can be arranged to allow backstopping, freewheeling, indexing and intermittent motion.

"Miniature Clutches With No Brushes," Feb 17 '58, p 99. New type has stationary housing that eliminates slip rings and brush assemblies. "High-speed Electrostatic Clutch," Feb '57, p 189, discusses principles of operation, construction and performance. "Fast Acting Magnetic Clutch," Aug '56, p 145; how circuit and clutch was modified to obtain fast response.

"Metal Shoes Prolong Clutch Life," Oct 14 '57, p 82, tells how metal shoes stopped formation of heat-checking cracks in high-inertia applications. "Graphical Method for Shoe Brake Design," Mar '56, p 142, discusses center-of-pressure concept for finding equilibrium of forces on friction clutches.

SEMICONDUCTORS

– REVOLUTION AT YOUR ELBOW

Not just transistors—from this new family of materials have come thermistors, solar cells, luminescent panels . . . and solid-state physicists see a growing number of fascinating, and important, applications ahead.

A STAFF REPORT

Those neither-fish-nor-fowl materials, the semiconductors, are cooking up a revolution in electronics. They're not good conductors. They're not good insulators. But their fence-straddling qualities are just what's needed for transistors, solar cells, rectifiers, thermoelectric junctions, thermistors, and electroluminiscent panels.

History of the semiconductor is a short one. Its first application was the crystal diode detector in World War II radar equipment. Then, soon after the war, transistors were discovered and the industry started to grow. **In the last five years, production of diodes and transistors has risen from $2.3 million to over $200 million a year.** At present, at least 23 companies are manufacturing over 500 different kinds of semiconductor devices.

This phenomenal growth continues as transistors find application both as replacements for tubes and where tubes won't do. New semiconductor components are continually being introduced on the market and several novel devices now in development, such as electroluminiscent panels, promise to be available in quantity within the next few years. Meanwhile, solid-state physicists keep on fussing with the basic physics of solids, hoping to expand the semiconductor field to even broader markets.

Revolt in Industry

The impact of semiconductors has been felt by four major fields: automatic control, communications, power generation and illumination. The first two have been heavily affected by the transistor and crystal diode; design of present equipment in the power generation and illumination fields is only beginning to be affected—by new products still under development.

AUTOMATIC CONTROL

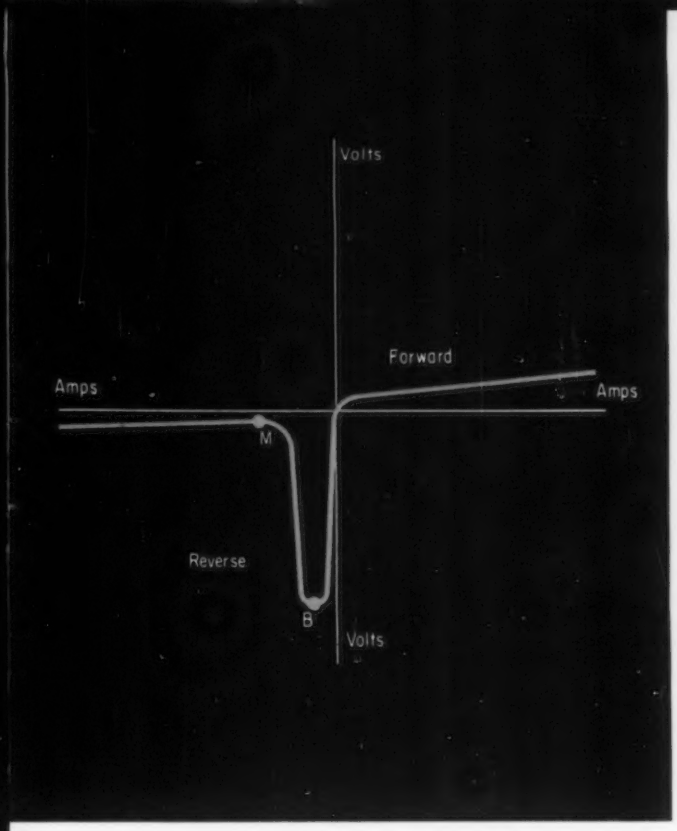
Semiconductors have invaded this field with rectifiers handling up to 100 kw, power transistors that can switch amperes of current at several hundred volts, and a variety of small diodes and transistors for high-speed, low-power switching and signal amplification.

New Switching Diode

Recently developed is the switching diode—a 2-terminal four-layer device that can switch speedily from high to low impedance. Shockley Semiconductor Labs (Div. of Beckman Instruments) recently announced these diodes in pilot production at its Palo Alto plant. There are experimental versions that will carry 11 amp continuously and can handle pulses up to 500 amp. Even better power-handling ability—up to 50 kw—is forecast for the near future. **These diodes will find wide use in static converters, motor controls, relay starters, frequency converters, and replacements for thyratrons and magnetic amplifiers.**

Switching speed makes them particularly suitable for computers and other fast-acting electronic equipment. Switching time from the blocking to conducting state (off to on) is of the order of 0.1 microsec; recovery time (on to off) is approximately 1 microsec.

A 3-terminal switch—a transistor switching triode—is made by attaching another terminal to the switching diode at an appropriate point. The third lead can be



Switching diode . . .
works somewhat like a thyratron with a fixed firing point. The diode is turned on with a reverse voltage pulse that exceeds the predetermined breakdown voltage at B. It's turned off by reducing current to below that of minimum "on" value at M or by cutting off supply voltage.

biased to aid triggering the device and to control switching voltage. Such devices will offer more design flexibility and finer control.

The Thermistor

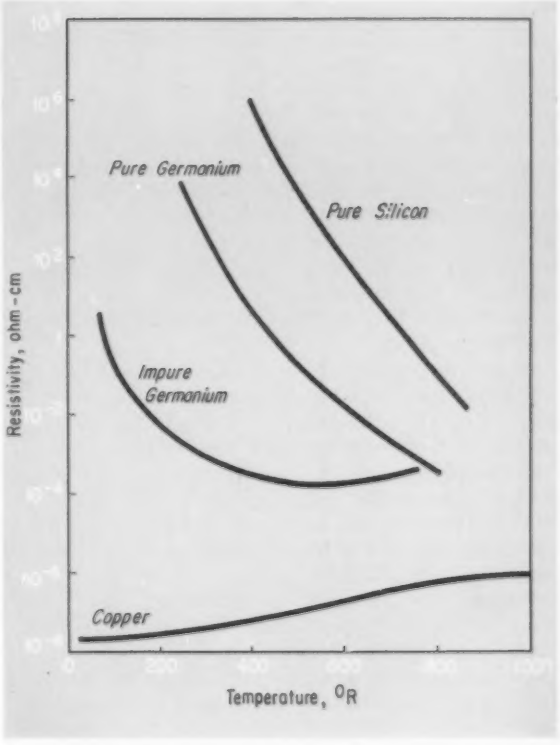
Another fast comer is the thermistor. This element, like all semiconductors (and unlike the conductors), has a large negative temperature coefficient of resistance (NTC)—resistance that drops with rising temperature. The NTC elements are commonly made from oxides of manganese, nickel, cobalt and other metals.

Some other semiconductor materials—called semimetals—can be fabricated with positive temperature coefficients, the result of change in mobility of electrons rather than a change in quantity (as with NTC materials). Resistance is nearly a function of the cube of absolute temperature which makes them ideal for controlling small temperature changes.

Research here is expected to develop thermistors that can stabilize systems accurately at any temperature. **When perfected, the all-electronic themistor will outperform most mechanical and electrical devices used today for temperature sensing.**

Jobs for the Hall Effect

Another important semiconductor device utilizes a phenomena named after E. H. Hall who discovered it in 1879. It works this way. When a conductor lies in a plane at right angles to a magnetic field, electrons carrying the current are forced to travel along one side of the conductor. Electrons build up on this side until an electric field is created that exerts a force on the



Negative temperature coefficient . . .
is the distinguishing feature of all semconductors. In metals, such as copper, resistance increases with rising temperatures; resistance in semiconductors (germanium, for example) decreases with increasing temperature.

electrons equal and opposite to that of the magnetic field. Resultant voltage is called the Hall voltage.

This technique has proven quite valuable in determining purity of semiconductor materials. It has also been found that with special shapes and with certain semiconductor materials, devices can be produced that generate substantial Hall voltages. Indium antimonide is used when high sensitivity is desired; indium arsenide, when stability is desired over a wide temperature range (—60 to 300 F).

Hall voltage is proportional to the product of the current and magnetic field; therefore a Hall generator can serve as a multiplier. These units can be used as elements in analog computers and wattmeters, and in measuring and controlling magnetic fields. With a "C" yoke around a bus bar and a Hall generator in the gap of the yoke, very large currents can be accurately measured and controlled.

This device, only in its infancy compared with diodes and transistors, promises to have applications elsewhere too. An important feature is its frequency response. Because the relaxation time of the Hall effect is so very short, theoretical frequency limit of the generator is of the order of 10^4 to 10^6 megacycles—therefore Hall generators can accurately measure the power content of transients in the microsec range.

COMMUNICATIONS

Much of the impetus for development of semiconductors in the early years came from communications. A variety of transistorized radios have appeared on the market in the past five years and laboratory models of transistorized TV sets have already been built. Transistors for communication are moving steadily toward higher power and higher frequency. **Present devices are already in the range of 1000 mc and new designs visualize raising this to 10,000 mc.** As amplifiers, present low-frequency germanium transistors can deliver as much as 35 w. And silicon transistors, which allow higher operating temperatures, **will soon be handling 750 w as amplifiers and switching as much as 10 kw of power.**

Recent development of the solid-state "maser" has put the semiconductor amplifier into the microwave range. This opens the possibility of amplifying microwave signals with **near-theoretical signal-to-noise ratio.**

Military requirements have emphasized the need for transistors and diodes operating between 570 F and 1800 F, for missiles and high-speed aircraft. This has spurred development of new semiconductor materials (such as gallium phosphide, gallium arsenide, and silicon carbide) to operate in the temperature range of 570 F to 930 F. Experimental silicon carbide rectifiers now can operate at temperatures above 1800 F. The communication field was first to greet the semiconductors. **And it will see development of the greatest number of novel applications in the near future.**

POWER GENERATION

Semiconductors will soon take a bold step into this industry with development of an effect discovered by Seebeck in 1821. He found that when two dissimilar metals were connected together and the junction heated, voltage was developed—a direct method of converting heat energy into electric power. This led to development of the thermocouple—the only application for many years.

Experimental electronic refrigerator . . .
developed by RCA Laboratories, has no moving parts and no refrigerants. Semiconductor elements do the work.

Thermoelectricity

Semiconductor theory brought about new understanding of this phenomena; certain materials were found to produce useful power from the Seebeck effect. The properties required are: good electrical conductivity, low thermal conductivity, high thermal emf and retention of all three properties at temperature above 2000 F. Most good electrical conductors are also good thermal conductors; but semiconductors can combine high thermal resistance and low electrical resistance.

The efficiency with which they convert heat into electric energy is shown in an equation quite similar to that for Carnot Cycle efficiency,

$$\text{Efficiency} = A\,\frac{T_h - T_c}{T_c}$$

where T_h is temperature of the hot junction, T_c of the cold junction, and A is a constant involving properties of the materials. Obviously, efficiency increases with T_h.

The method looks especially promising for atomic power. High temperatures that result from atomic reactions would be wasteful when used to develop power by conventional means, but could be efficiently converted into electric energy by thermoelectric junctions. When junctions made with the most recently developed materials are cascaded, efficiencies com-

Electroluminescence is newest . . .
of man's light sources. It is used here to form letters and figures of a new digital display. Westinghouse says this one is bright enough to read in broad daylight.

parable with or better than existing commercial counterparts may be possible. **Look for these power plants in the next 10 years in military aircraft, ships, and large vehicles.** Russia already claims to have power-generating thermoelectric junctions heated by a kerosene lantern.

Solar Batteries

Another semiconductor device that promises power generation, though in a more restricted manner, is the solar battery. Power produced depends on the voltage developed across a semiconductor diode illuminated with light of the proper wavelength. The voltage causes a current to flow through the diode. Silicon diodes are the present favorite for solar batteries, but other semiconductors show promise.

The silicon batteries have shown power conversion efficiencies up to 8%. This probably limits the idea to delivering small power because a large power supply would involve many bulky batteries for storage during periods of darkness, and light-absorbing areas so large as to be impractical. Also, the method would require a high number of sunny days per year. However, **with no fuel costs and no moving parts to replace, this method of power generation has promise for certain applications.**

Cooling with Electronics

Thermoelectric cooling, often called "Peltier cooling," is an area related to power where semiconductors are also playing a big role. The Peltier effect is the reverse of the Seebeck effect—a current passed through junctions of two dissimilar materials causes heat to flow. Here again, the effect was only a laboratory curiosity until recently.

Some semiconductor materials have led to Peltier junctions with temperature differences of 120 F. As with the Seeback effect, cascading the junctions results in increased efficiency. The Russians have reported developing junction devices capable of temperature differences of 160 F and multiple couples in which the cold junction was reported to operate at —50 F.

Present technology has already brought this revolutionary method of cooling within a factor of two from outmoding present refrigeration systems.

ILLUMINATION

A phenomenon called electroluminescence, discovered some 35 years ago, promises a new concept of lighting for home and industry. The long word means generation of light in a solid material when it is excited solely by electric fields or currents—without bombardment, irradiation, or external heat.

In 1936, Destreau observed that a zinc sulfide phosphor embedded in an insulator would emit light when subjected to intense alternating electric fields. The phenomenon has received intensive study since 1950 and has resulted in development of electroluminescent lighting panels of all shapes and sizes, emitting colors ranging from yellow-green to red.

The phosphors here are quite similar to those in TV tubes: They contain luminescent centers formed by carefully controlled amounts of impurities added to the base material. However, with TV phosphors (cathode-luminescent material), excitation is caused by direct electron bombardment, whereas electroluminescent materials are excited indirectly by a field. The best-known phosphors for producing this phenomenon are those of the zinc sulfide and zinc selenide classes, but electroluminescence has also been reported for other similar materials and some organic compounds as well.

A typical panel is a sturdy sandwich construction. The phosphor, embedded in a coating of glass or plastic, is pressed between two conducting electrodes: one, a metal backing plate; the other, a transparent conducting film. The exciting voltage is applied across the electrodes.

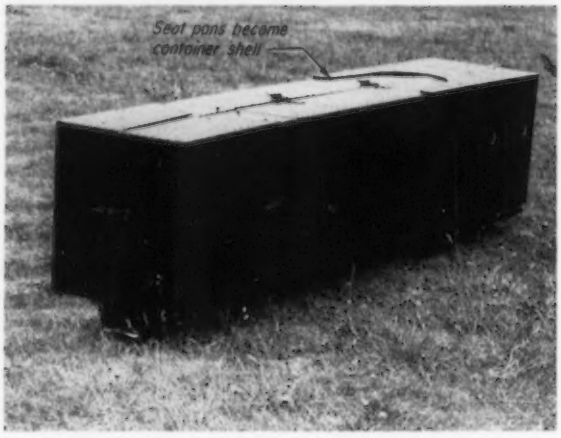
At present, the panels are about 3% efficient as compared with 20% for fluorescent lamps. **However, the intense research on phosphors demonstrates confidence that the goal is near—that we will soon be able to light our homes and offices with complete ceilings or walls made of electroluminescent panels.**

EDITOR'S NOTE: For the advantages and limitations of transistors as control components, see "Transistors vs Tubes for Industrial Applications," Oct 28 '57, p 52. "Exotic Metals Seek Employment," Mar 17 '58, p 66, gives an up-to-date look at some of the metals used in semiconductors and a review of their other properties.

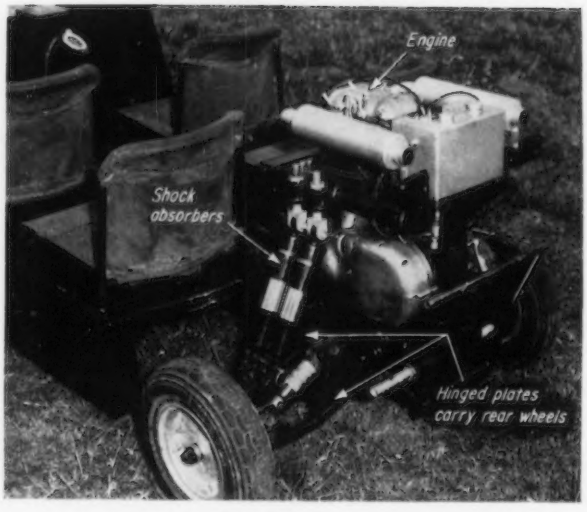
For air transport . . .
jeep becomes self-container that can be stored in planes without special racks, requires under 1/5 the volume of a standard ¼ ton truck and is ¼ the weight. Length is 9 ft; volume, 33 cu ft. Frame is a central aluminum-alloy beam with sheet aluminum pans hinged on either side. These pans carry the seats and form container shell when folded. Jeep has a flat bottom that lets crew slide it over rough ground. Ground clearance is adjustable but usually set at 6½ in.

Folding Jeep Carries Four

Last word in smaller personnel carriers is this midget with a mission. It turns into its own container for air transport and parachute drops. Unfolded, it carries four passengers at 60 mph.



Made by Hunting Percival Aircraft Ltd., Luton Airport, England, the vehicle represents a new concept in military equipment. Folded container is carried easily by the four-man crew and unfolded for use in a minute. Design uses aircraft materials and production techniques to keep weight down to 700 lb.

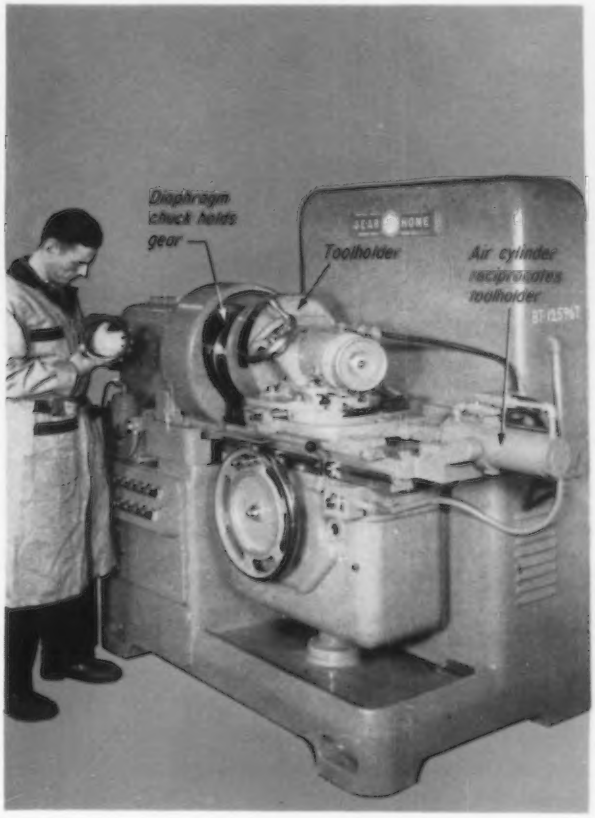


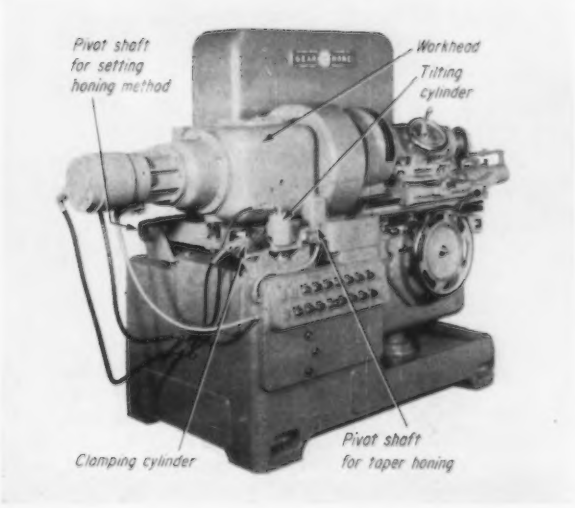
Rear wheels . . .
are driven through a chain drive powered by a two-cylinder motorcycle engine with 650-cc displacement. Drive has no differential. Rear wheels are individually suspended on hinged plates and fold in front of the engine for shipment. Front wheels too are individually suspended from the frame beam on parallel wishbone linkage. They fold for packing without disconnecting the steering gear, a rack and pinion that turns the wheels through ball joints.

Work Tilts Against Tool

An air cylinder tilts the workhead of this honing machine to press gear teeth against the honing tool. This lets gears be honed two ways, with either constant backlash or constant pressure between workpiece and tool.

Called the Model GHC Red Wing, machine removes nicks or burrs and improves surface finish of either spur or helical internal gears with 4 to 6-in. pitch dia. Taper and crown honing operations can also be done with the machine, which was designed by the National Broach & Machine Co., Detroit.





Gear is pressed against tool . . . when air cylinder over control panel tilts workhead upward about shaft at back of machine. For constant-backlash honing, the gear is brought into tight mesh with the tool and a second air cylinder locks the gear in position for the honing cycle. This fixed-center-distance method is used for gears within commercial tolerance specifications. For constant-pressure honing, the gear is tilted into the tool as before, but not locked in position. Tilting cylinder lets it float against the tool with constant pressure. This method is used for gears not held to commercial tolerance ranges. A second adjustment tilts the head to fixed positions about a transverse shaft for taper honing. This is done with a micrometer screw.

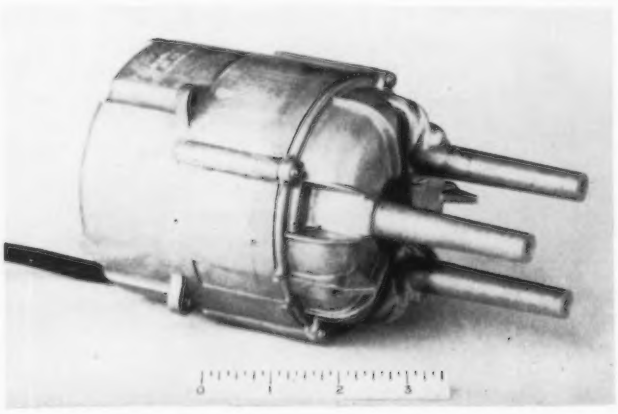
Immersed Motor Stays Dry

Shaded-pole motor that drives agitator of this tub-less washer is encapsulated so it can run underwater. The portable unit converts any tub, pail or sink into a washer that does a 4-lb wash in 7 to 10 min.

Standing just over a foot high and weighing 9 lb, washer is ideal for the traveler or light housekeeper. AMI, Inc., Grand Rapids, Mich., builds the device. Special motor was designed by the Specialty Motor Dept's. Product Planning Section of the General Electric Co. plant, Fort Wayne, Ind.

Tumbling and aeration . . .

are produced by up-and-down motion of the agitator's molded nylon scrubbers; scrubbers also produce a gentle hand-rubbing action. Clothes are tumbled through the water by air bubbles introduced by ducts leading to underside of agitator disk. This aeration action increases cleaning efficiency of the detergent.



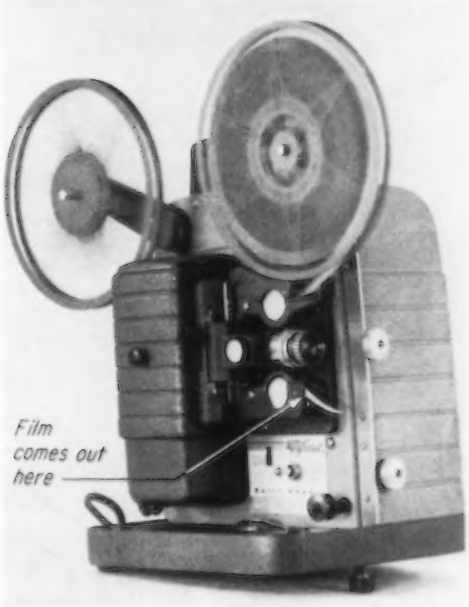
Encapsulating the motor . . .

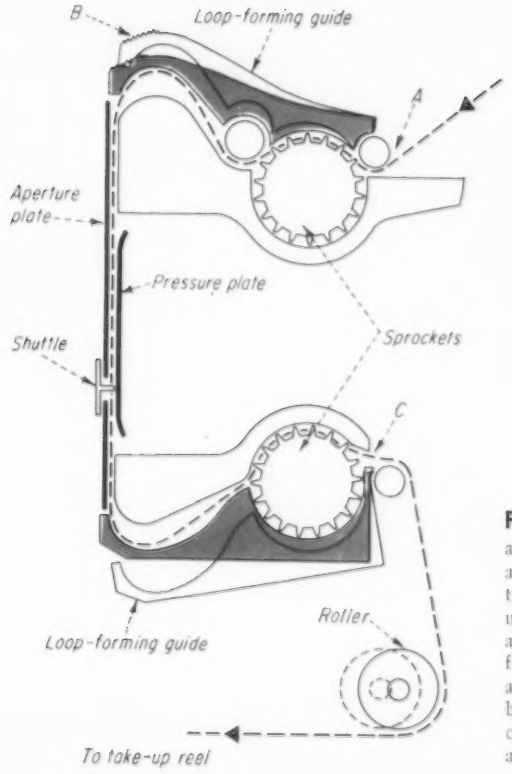
was protective method selected to get Underwriter's approval—because unit runs immersed in water and suds. The 1/20-hp motor also needed a high starting torque and a 105-C maximum winding temperature. Full-load speed is 1550 rpm and break-away torque is over 20 oz-in.

Projector Threads Itself

Film inserted into the mechanism of an 8-mm movie projector is threaded automatically through the shuttle and the drive sprockets. Loop-forming guides determine film path until take-up reel exerts tension.

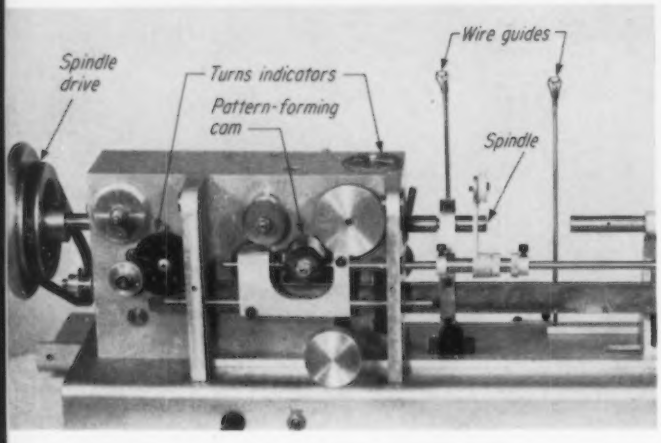
Designed by Bell & Howell to simplify setting up for home movies, the Auto Load projector threads itself in less than 3 seconds. It was developed after a consumer attitude survey showed that over 80% of people questioned were in favor of automatic equipment—they wanted to avoid delays from mechanical mishaps that destroy audience interest.





Film is inserted . . .

at *A* after loop-forming guides have been closed. Guides are linked (not shown) so pressure at *B* will move both of them to the threading position. Top sprocket drives film under roller, through upper loop-forming guide, between aperture and pressure plates, and past shuttle to lower loop-forming guide. Then film is engaged by bottom sprocket and discharged at *C*. Operator leads film under roller and back to take-up reel. Linkage between roller and guides causes them to move out of threading position when reel absorbs slack and applies tension to film.

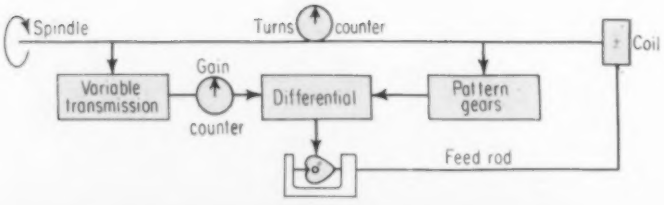


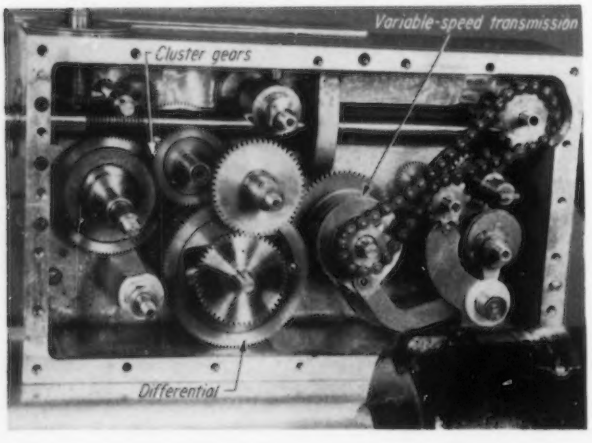
Self-supporting coils . . .
are wound on this machine. Their lattice or basket-weave pattern makes adhesives or side flanges unnecessary. Pattern and turn spacing must be adjusted critically to give such coils adequate mechanical strength. This is done by trial and error. Patterns are formed by the traverse cam. It leads the wire back and forth across face of the coil each time the spindle rotates. If cam and spindle have same speed, wire-turns fall atop each other and the coil will fall apart. Proper turn spacing is obtained by introducing a lead angle. The angle that the wire makes with the face of the coil sets the winding pattern and the coil's stability. Angles vary from 7° to 20° but 12° is ideal.

Gears Compute Coil-winding Data

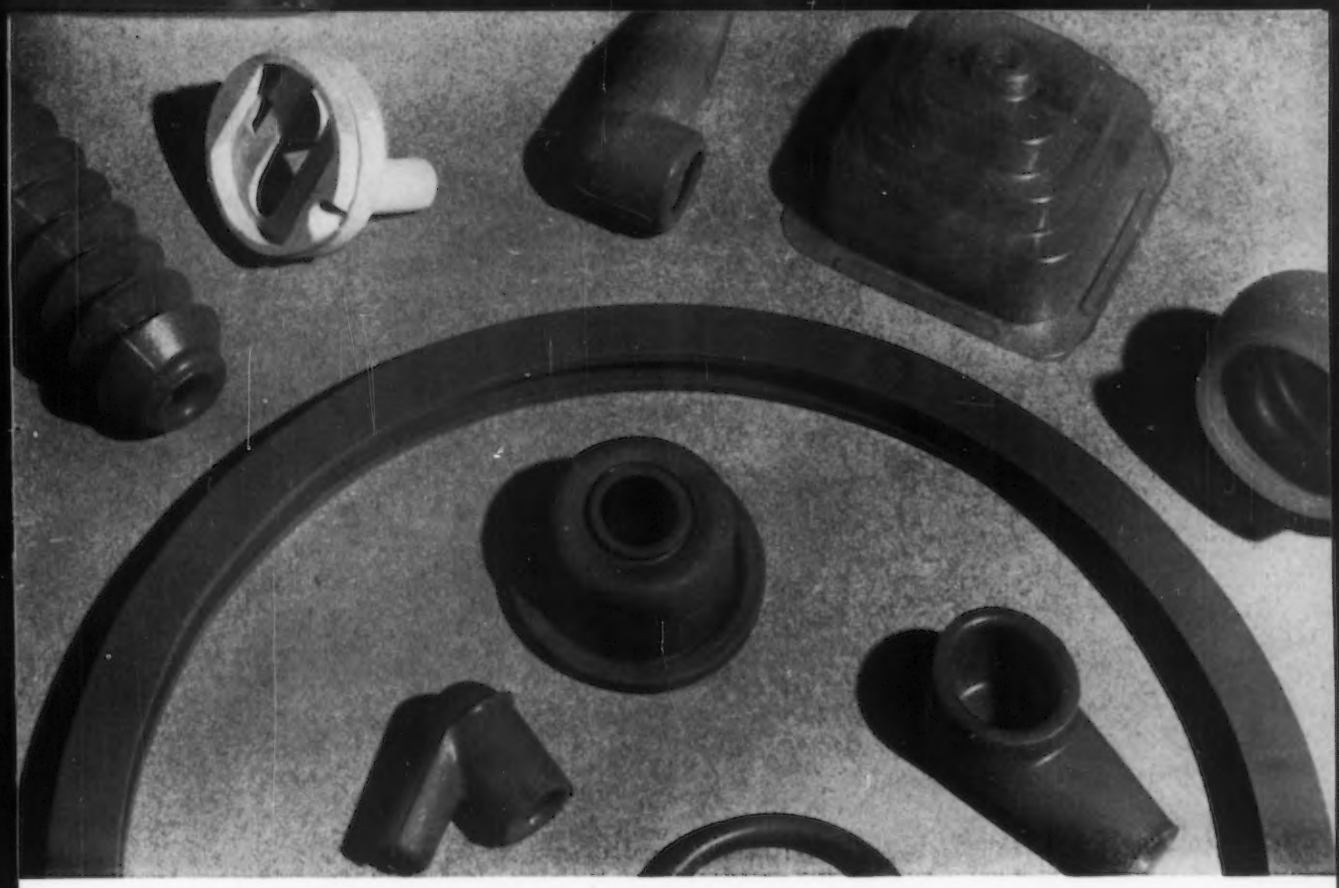
First this machine winds trial coils to find the right speed ratio between its winding spindle and cam that governs its reciprocating wire-feeding device. Then it uses this ratio to turn out production coils.

Basket-weave coils are produced on this model WX machine made by the Coil Winding Equipment Co., Oyster Bay, N. Y. The gear ratios it determines can also be used to let other machines reproduce the trial coil when large quantities must be made.





Coil is wound . . .
on a spindle that drives an accurate turns counter and a variable-speed transmission. The transmission output speed is registered by a pointer. The spindle also drives a gear cluster with a fixed speed ratio. Outputs of the gear cluster and the variable-speed transmission are fed to a differential. Output of the differential drives the pattern-forming cam at a speed that is the difference between speeds of the gear cluster and the transmission. This difference is usually an odd ratio like 28:27 and is read from the dials that indicate how many turns were made by each shaft. Machines geared with this ratio will reproduce the coil.



ground rules for . . .

MOLDED SILICONE RUBBER PARTS

The same product that thrives on abuse at high temperatures may be a weakling during installation. Here are tips on curing methods, shape of part and other variables that determine satisfactory service.

D. P. SPALDING, *Phd*
Silicone Products Dept.
General Electric Co.

There is a significant oddity about parts molded from silicone rubber. Put them to work at challenging high temperatures and they stand up. But before that, they must be installed–and here is where they're liable to tear. Reason is the silicones are weaker than other elastomers at normal shop-handling temperatures. This is why special care–in design, selection of material, curing cycle–is needed to get required strength in parts like spark plug boots, transmission seals, regulator diaphragms and O-rings that have to take considerable pulling and hauling during installation.

The difference in strength is more understandable after examining the make-up of such parts. Silicone elastomers are prepared for molding by mechanically rolling together the basic gum, appropriate fillers and additives, and a peroxide catalyst. Variations of these, plus special curing after the part is vulcanized in the press, give four classes: general-purpose, low compression set, low-temperature, and high-temperature. The extra curing is essential for parts that must operate above 300 F; it stabilizes properties and extends life.

The oven-cured product is not as tough as material in the "as vulcanized" state, and oven-cured parts may tear during installation. Here are two alternatives: **Do not over-cure**–choosing the minimum cure for the required profile of properties will give the toughest rubber at room temperatures; **cure the part after installation** if circumstances permit so that the higher "as-vulcanized" toughness at room temperature will prevent tearing when the part is installed.

Simple shapes are best because the conventional curing systems are fast-acting–leading to uneven properties in intricate parts. This can increase danger of tearing when the part is removed from the mold or during its

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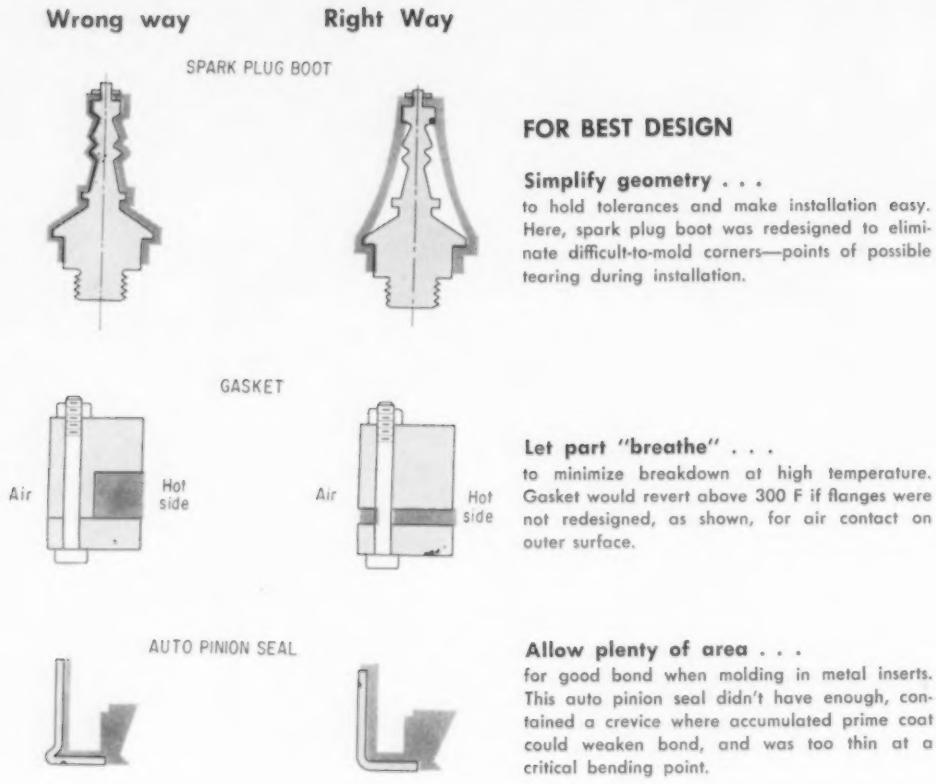


FOR BEST DESIGN

Simplify geometry . . .
to hold tolerances and make installation easy. Here, spark plug boot was redesigned to eliminate difficult-to-mold corners—points of possible tearing during installation.

Let part "breathe" . . .
to minimize breakdown at high temperature. Gasket would revert above 300 F if flanges were not redesigned, as shown, for air contact on outer surface.

Allow plenty of area . . .
for good bond when molding in metal inserts. This auto pinion seal didn't have enough, contained a crevice where accumulated prime coat could weaken bond, and was too thin at a critical bending point.

installation. Other advantages of simplicity are lower mold cost, lower production costs, and less stress concentration in the finished part.

But simple shape does not limit part size. With material cost dropping as applications broaden and production increases, larger molded parts become economical. For example, a new liquid-cooled turbine generator carries 96 flexible insulator boots, each 12 in. long with 4-in.-dia corrugations. Under development are tougher and easier processed silicone rubbers that will permit more intricate molding, higher tear strength and better performance at higher temperatures.

THESE ARE THE PROBLEMS

Three main considerations underlie design for best service from silicone rubber parts.

Reversion, a tendency to lose rubber-like characteristics and change to a paste or powder, may occur if the material cannot "breathe." The key temperature is 300 F; above this, the part can be expected to revert if it operates completely sealed from air. However, even slight venting of the part will eliminate the reversion problem up to 500 F. But above this, a more open environment for the part must be devised. Above 600 F, selection of a compound with minimum reversion tendencies and special curing cycles are also required.

Shrinkage is a problem here as with other rubber material, and has three classifications depending on how much the oven-cured part varies (± 1%) from mold dimensions: 6%, 3%, and 1.6%. Production cannot be held to metal-parts tolerances, and a good rule of thumb is ±0.01 in. per in. Tighter tolerances can be maintained, but at higher production cost. Thermal coefficient of expansion, 2.5 to 3.5 x 10^{-4} in./in./°C over the range 25 to 250 C, controls critical dimensions of the molded part in service.

Chemical resistance varies with media—but even in a given fluid, performance varies with commercial grades. While silicone rubber is sometimes classed "inert" compared with other elastomers, there are definite limitations: It excels in oxygen and ozone resistance, as it does in water and dilute water solutions of salts, acids, and bases; resistance to solvents like alcohols and ketones is good, but poor to most hydrocarbon or aromatic lubricants. Synthetic lubricants such as diesters are very degrading, particularly at high temperatures, and silicone lubricants serving as mold releases for other elastomers cannot be used.

9 TIPS ON DESIGN

The designing of economical and efficient parts molded from silicone rubber will also be aided by these simple guides:

- Thickness should be kept to a minimum. Besides cutting cost, this helps the molding "breathe." However, any silicone rubber can be molded under any cure, in thicknesses to ¼ in. Thicker sections are limited to certain compounds and cures, but durometer hardness is not limited.
- Metal inserts bonded during molding will reinforce the part, permit attachment to other parts, or maintain

Four Silicone Rubbers Compared

Property	General-purpose	Low Set	Low temp.	High temp.
Durometer hardness, Shore A	40–80	50–90	40–80	40–80
Tensile-strength range, psi	500 to 1000	500 to 1000	500 to 1500	500 to 1000
Elongation range, %	100 to 400	100 to 200	100 to 600	100 to 300
Limiting-use temp., F Max Min	 500 −70	 500 −70	 500 −150	 700 −70
Compression-set range, %	20–50	10–30	30–60	20–60

Long Cures Mean More Shrinkage

Cure	Percent Shrinkage from Mold Dimensions for:		
	Normal silicones	Low-shrink silicones	Extreme low-shrink silicones
As-vulcanized	3.0	1.5	0.8
Short oven cure (300 F)	4.0	2.0	1.0
Long oven cure (480 F)	6.0	3.0	1.6

Oven Cure Forces Choice: Heat Stability or Toughness

Oven cure	Room-temperature Properties			
	Tensile Strength, psi		Ultimate Elongation, %	
	Before heat aging	After heat aging	Before heat aging	After heat aging
1 hr at 300 F	1110	620	380	235
4 hr at 480 F	765	720	245	235
24 hr at 480 F	660	650	240	205

shape. Steel or aluminum inserts are prime-coated with silicone monomer before the rubber part is molded in place. Brass and bronze are difficult to bond. Cured-rubber moldings can be adhesive-bonded to reinforcements, but the bond strength is usually weaker than by insert molding. Properly primed fabrics are good reinforcements—glass cloth for high temperatures, and synthetic fibers like Dacron and Orlon for lower temperatures—in thin parts like diaphragms and gaskets.

• Flat parts like gaskets can be die-cut from flat sheet, but only for small orders because waste is high. In large quantities, molded parts are better—the mold costs are quickly repaid by savings in material. To minimize danger of tearing, holes for mounting or venting should be designed into the molding rather than punched at installation.

• Molded identification markings are better than inked or dyed coding because the silicone will withstand temperature extremes far better than the marking material; also, silicone surfaces are difficult to wet with these agents. Although silicone rubbers vary from brown opaque to clear, light amber, they take color additives easily without detriment to properties—a good method for styling as well as coding.

• Make a prototype molded part using a single cavity mold—to insure proper performance and tolerances before spending money on a multi-cavity mold. Here, the qualified fabricator and supplier can give good advice because molding is still part science and part art.

• Test the finished part at operating temperatures, for only in this way can final properties be evaluated. Silicone rubbers, in contrast with organic elastomers, stabilize after aging and do not exhibit a continual decline in properties with time. Thus, customary rubber-testing techniques are often inapplicable.

• Specify the minimum tensile strength desired after aging at use temperature, rather than the percent drop in tensile strength during aging. This permits the shorter cure cycle that gives higher room-temperature toughness for installation (see stability table above).

• Examine costs carefully before specifying a silicone rubber molding. The synthesized silicone gums are expensive, and secondary curing often runs up production costs. These materials should be chosen only when their resistance to extreme environmental conditions makes them economical in the long run.

WHICH TEMPERATURES ARE IMPORTANT

Outstanding characteristic of silicone rubbers is elastic action over a wide temperature range, from —150 F to above 500 F. Reversion is most troublesome at elevated temperatures. The temperature limits to keep in mind when designing molded parts are:

To 300 F All compounds have indefinite life in either sealed or vented systems.

Above 350 F In sealed systems, no compound will last more than a few days.

To 400 F In vented systems, all compounds have indefinite life.

Above 500 F All compounds in vented systems will hold up for months.

Above 600 F Special compounds must be formulated, even for vented environment, and dependable service is limited to days.

Above 700 F These same special stocks have a life expectancy of hours, vented.

REPRINT of this article can be obtained for your reference file by checking No. E20 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 147.

A FRESH LOOK AT

LEADED STEELS

Thanks to improved techniques, the addition of lead now gives steels with good machinability—and less worry about loss of tensile, impact, and fatigue strengths. Here's helpful design data.

W. SIMON
Materials Engineering Dept.
Westinghouse Electric Corp.

Afraid of what fatigue may do to parts? You wouldn't be if you could design with the bone of living animals—this material constantly repairs any damage it suffers from repeated stressing. But bone happens to be the only material immune to fatigue failure. Others require clear conceptions about fatigue, and a certain amount of compromise with the ideal. The new leaded free-cutting steels are an example.

They still have to live down their reputation for low mechanical properties. But although they remain somewhat low in fatigue strength, this drawback has been reduced in importance. The leaded steels are now worth re-examining because of the savings they give in faster machining speeds, longer tool life and increased production. All regular grades of carbon and alloy steels can be obtained in the lead-modified form, so substitution is simple and easy.

Formerly, when made with a lead content over 0.5%, they had lower tensile strength and ductility as well as untrustworthy fatigue properties. This was largely because of segregation; it accounted for a composition poor in uniformity and unpredictable in fatigue resistance. Thanks to improved techniques, the lead can be reduced in content and distributed better to give steels higher in ductility, tensile and fatigue strengths—while retaining their valuable free-machining characteristics.

The relative ease of machining leaded steels pays off most noticeably with steels hardened for high strength. For example, when designing parts that will take 200,000 psi, the steel hardness must be Rc 44, and 250,000 psi requires Rc 52. At such hardness levels, ordinary steels are difficult to machine and the addition of lead is most helpful in reducing machining costs.

Figuring Strength Loss

Despite the savings they offer, leaded steels must be used with discretion because of their drop in fatigue strength. This is why accurate design data is necessary and the accompanying chart is helpful. It correlates the loss of fatigue strength at various tensile strengths. All data given in chart and tables are for the new leaded steels.

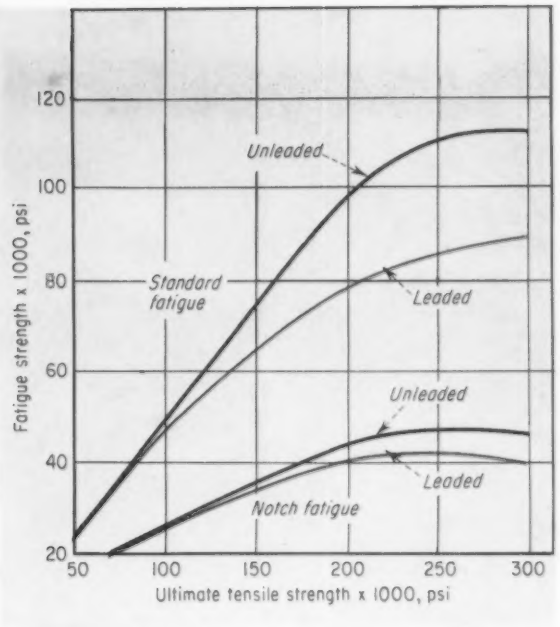
Chart shows that for wrought steels the fatigue strength increases proportionately with the tensile strength, then levels off. By contrast, the fatigue strength of leaded steels starts dropping beyond 100,000 psi. The chart also shows that up to 300,000 psi, lead causes no significant loss in notch fatigue strength.

A good guide furnished by the curves is this—for steels under 100,000-psi tensile strength, there is little difference in the standard fatigue strength, and free-cutting leaded steels can be substituted without worry.

Leaded vs Sulfurized Steels

In addition to superior fatigue properties the new leaded steels offer these advantages over the sulfur type of free-cutting steels.

• **Higher impact strength.** There is no significant difference between impact strengths of leaded 4140 and its unleaded cousin even at temperatures as low as −148 F. By contrast, a sulfur-type free-cutting steel, for example



Adding lead . . .

lowers fatigue strength of wrought steels when tensile strength goes above 100,000 psi. Effect is less on notched fatigue.

B1112, loses 50% of its Charpy V notch strength with the addition of sulfur.

• **Hardens better.** For the same tensile strength, a leaded 4140 steel will harden to 230BHN through a 5¾-in. diameter while AISI 1144, a sulfur type, will harden through a dia of only about 1 in.

• **Higher yield strength.** Between the leaded and non-leaded steels there is little difference in mechanical properties, but AISI 1144 sulfurized steel hardened to 110,000-psi ultimate tensile strength has 15% lower yield strength than leaded 4140 steel at the same ultimate strength.

Leaded Steels Cost More

Close control of composition is a must. Lead must be kept above 0.15% for good machinability and below 0.35% to retain mechanical strength. This control makes these steels cost about 15% more. But they allow a cutting rate 35% to 50% faster, and thus offer longer tool life. This plus other advantages adds up to a production rate up to three times faster. Savings are even more pronounced when machining time is high in proportion to the setup time. A rule of thumb is: Choose these leaded steels whenever the savings they offer are greater than the additional cost of material.

Can Replace Manganese Bronze

In a typical case, changing a 5-in.-dia piston from cast manganese bronze to leaded 4140 steel cut machining time and lowered material cost from $19 to $13. The finished part also had higher strength and ductility.

COMPARISON: LEADED VS UNLEADED STEELS

Average Tensile and Impact Properties

	Leaded 4140	Unleaded 4140	High-sulfur AISI 1144
Hardness, BHN	226	228	223
Yield strength, psi	84,270	83,620	72,750
Ultimate strength, psi	109,870	110,480	108,500
Elongation, %	23	22	19
Reduction in area, %	61	62	46
Impact strength, ft-lb	74	63	30

Low-temperature Impact Strength
(AISI 4140 at 350 BHN)

Temperature, F	Type of Notch	Impact Strength, ft-lb	
		Leaded	Unleaded
80	Charpy-V	36–39	46–54
	Keyhole	23–24	28
−58	Charpy-V	26	26–29
	Keyhole	18	20–22
−148	Charpy-V	26	27–31
	Keyhole	16–18	19

HOW LEAD CUTS MACHINING TIME

(B1112—High-sulfur free-cutting steel; Ledloy A—Leaded free-cutting steel)

Part	Operation	Cutting Speed, ft/min		Pieces/hr	
		B1112	Ledloy A	B1112	Ledloy A
Magnetic Core	Turning	150	292	137	416
Stop-pin	Turning	79	149	385	835
Bushing	Turning	120	200	99	303
Guide	Turning	165	246	60	153
Spacer	Turning	53	90	73	147
Screw	Turning	120	172	196	322
	Threading	24	46		
Screw	Turning	98	159	92	170
	Threading	20	38		

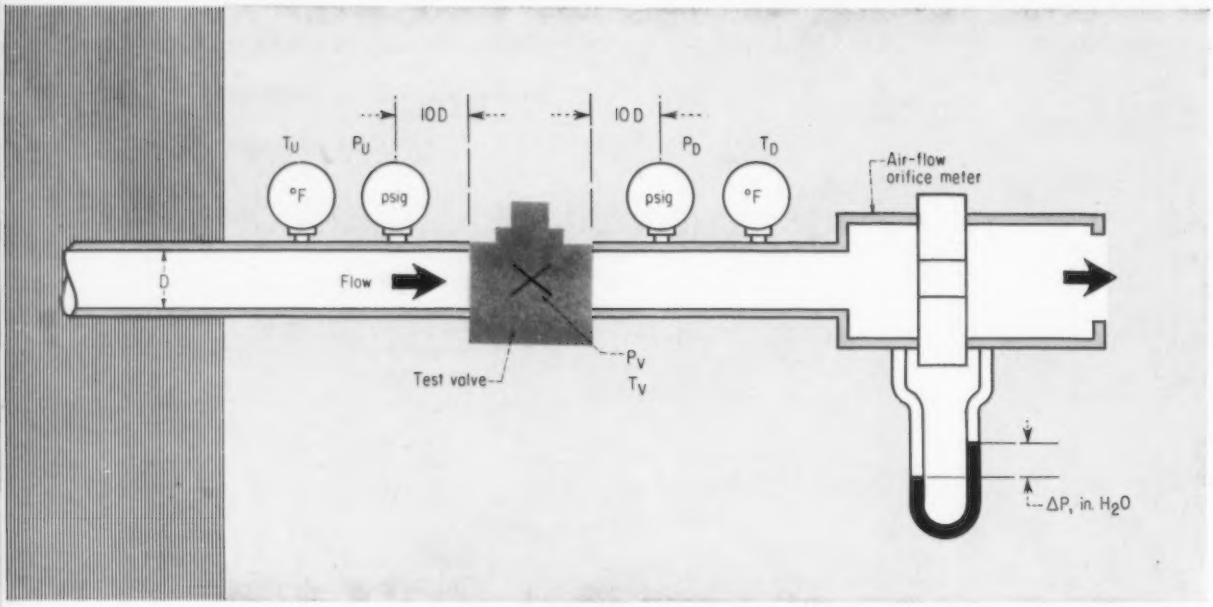
EDITOR'S NOTE: For additional information on how to combat fatigue failures see:

"Peening Cuts Stresses in Plated Parts," Dec 9 '57, p 92. Describes how shot-peening prevents plating cracks and increases fatigue life.

"How to Prevent Fatigue Failures," Oct '55, p. 174. Practical, nonmetallurgical discussion of reasons for fatigue failures. Gives design suggestions for increasing fatigue life of bolted, riveted and welded joints.

"Why Parts Fail," Aug '54, p 129. Detailed analysis of 12 case histories, most of them fatigue failures.

"Predicting Fatigue Failures of Notched Specimens," Apr '55, p 177. So-called stress raisers may be more readily understood if considered as strain raisers.



Actual conditions are simulated in this calibration setup. Readings are taken far enough upstream and downstream to avoid disturbed region near valve; then pipe losses are subtracted to give truer valve loss.

updating the K-factor formula for . . . PRESSURE DROPS in AIR VALVES

This consistent technique estimates pressure losses in a pneumatic system, component by component. Author's charts give K-factors for actual valves and fittings; nomogram provides fast pressure-drop answers.

BOYD DAHLE,
Chief Design Engineer
Clint Miller, Project Engineer
Parker Aircraft Company

A big help in estimating the pressure drop through an air valve comes from applying a simplified version of one of the oldest and most respected of natural laws —Bernoulli's conservation-of-energy theorem. This version brushes aside as negligible such effects as heat loss, wall friction (small because of short length), leakage, external work, and change of elevation, but takes into account the rapid velocity changes and other disturbances occurring inside the valve:

$$dP + \frac{\rho V\, dV}{g} + K\,\frac{\rho V^2}{2g} = 0$$

where ρ is density, lb/cu ft; V is upstream velocity, ft/sec; P is pressure, psfa; and K is a constant.

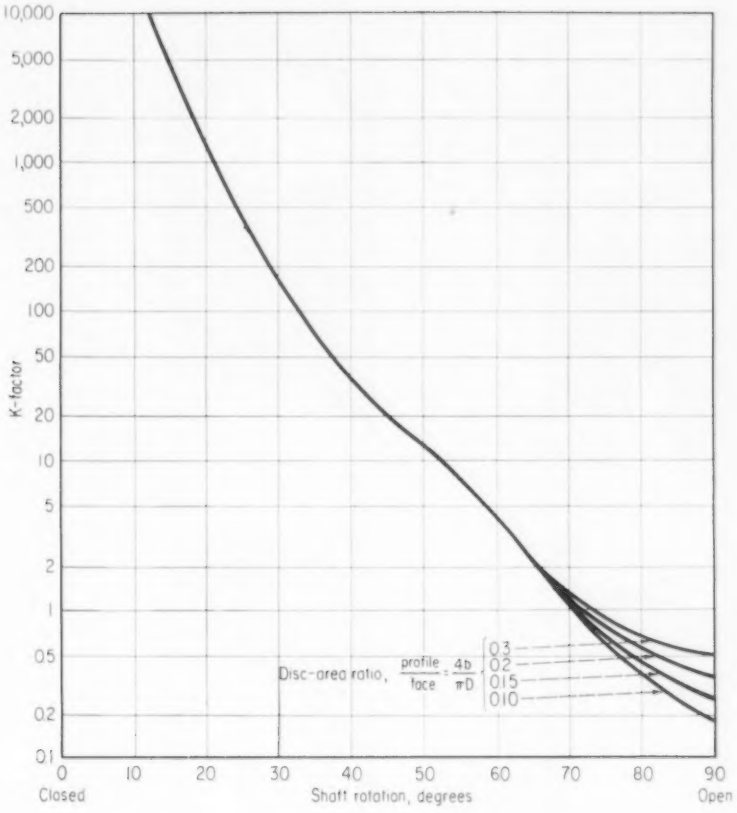
Then, by assuming output velocity is the same as input velocity, a final simplification gives a working formula where the constant K becomes extremely useful.

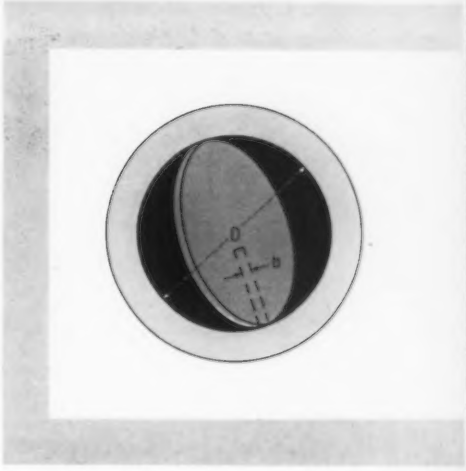
$$\Delta P = K\,\frac{\rho V^2}{2g}$$

where ΔP is pressure drop, psf, and K is the dimensionless K-factor.

This empirical relation can usually be applied to each component in any pneumatic system. It is reasonably accurate in the turbulent-flow range, where most valves operate. It also offers a consistent technique, eliminating confusion caused by the multitude of other methods now in vogue, some good, some bad. Some of these other methods are summarized on the last page.

With the K-factor formula, all that remains is to find the value of K. Here experimental data are essential. Vast quantities of pressure-drop information are avail-





Butterfly valve . . .
changes flow pattern for each position. This test-proved chart of K-factors is needed for accurate prediction of Δ P.

able for straight lengths of pipe, standard orifices, ducts and bends, but there is less for special pneumatic components, such as butterfly valves and complex fittings shown in charts.

A manufacturer using this approach should try to approximate a typical customer installation when he tests components. It would be misleading, for example, to use special entrance and exit ducting to smooth out air flow just to make the valve look better. A typical test rig, shown in flow diagram on first page, was constructed with inlet and outlet pipe sizes and connections similar to those expected at final installation. Measurements were taken 10 diameters of straight pipe upstream and downstream to lessen possibility of false readings caused by local velocity phenomena near the valve. Calculated pressure drops in these 10-dia lengths were subtracted to give only the drop in the valve (including the normal entrance and exist losses).

REACHING AN AVERAGE

To improve accuracy, many simultaneous readings are taken of pressure, temperature, flow . . . these are substituted in the *K-factor* equation.

K is essentially unaffected by variations in temperature, pressure and flow. This makes it possible to obtain data under one set of conditions, and apply it later to any other. The contours of each valve or fitting will markedly affect K, however, and new tests must be run after a design change has been made.

TEST FOR BUTTERFLIES

Inasmuch as a butterfly valve is a disk that may be adjusted (by rotation about an axis perpendicular to flow) to close entirely, or open to any desired position, the air flow path around it is complex. This means a family of *K*-factors is necessary to cover all degrees of opening. Values plotted for them in the accompanying chart have been verified by extensive tests.

Valve-bore area, disk thickness, and angle are each given consideration. The ratio of disk-profile area bD to valve-bore area $\pi D^2/4$ is important for small degrees of shaft rotation from open position. Although the specific curves shown do not cover every type of butterfly valve, the general form can be used to predict performance when one or more data points are known.

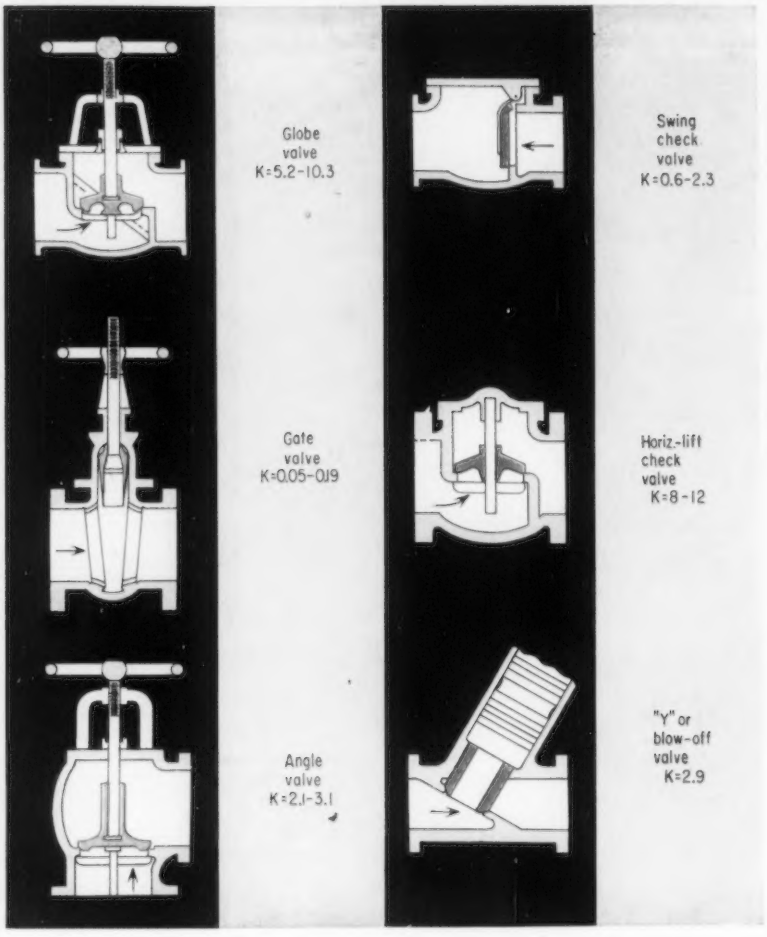
IT WORKS FOR ANY COMPONENT

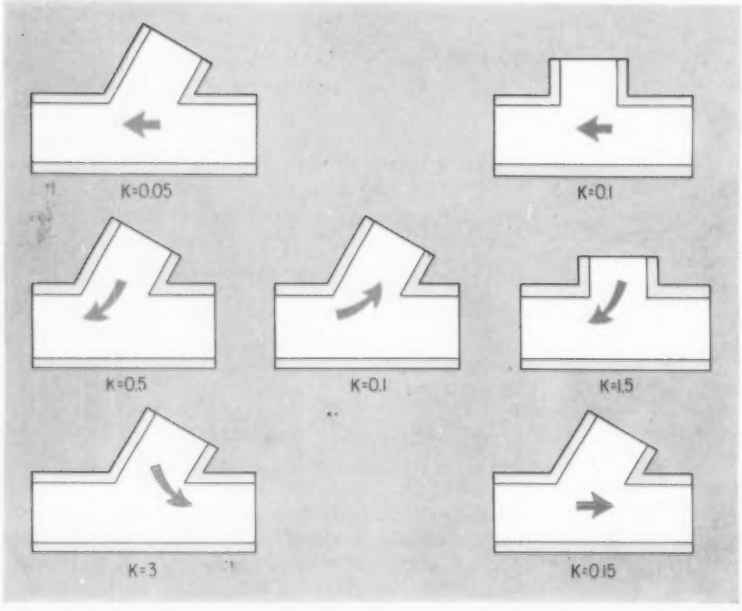
The remaining illustrations, tables and graphs give *K*-values for typical pneumatic valves and fittings. The nomogram equates pressure loss, flow and *K*-factor for the equation:

$$\Delta P = K \frac{R(T + 460)\left(\frac{W}{60}\right)^2}{2gPA^2}$$

which is a variation of simplified *K*-factor equation above. W is lbs/min flow, T is °F, P is psia, R is air constant, 53.3, and A is upstream flow area, in.^{2}. Any one of these variables can be read if the other two

These typical *K*-factors . . .
will serve as basis for predicting flow in any similar valves.





Duct connections . . .
have lower resistances than screwed pipe, despite sharpness at corner of turn. This is partly due to reduced inlet and exit losses of a duct assembly.

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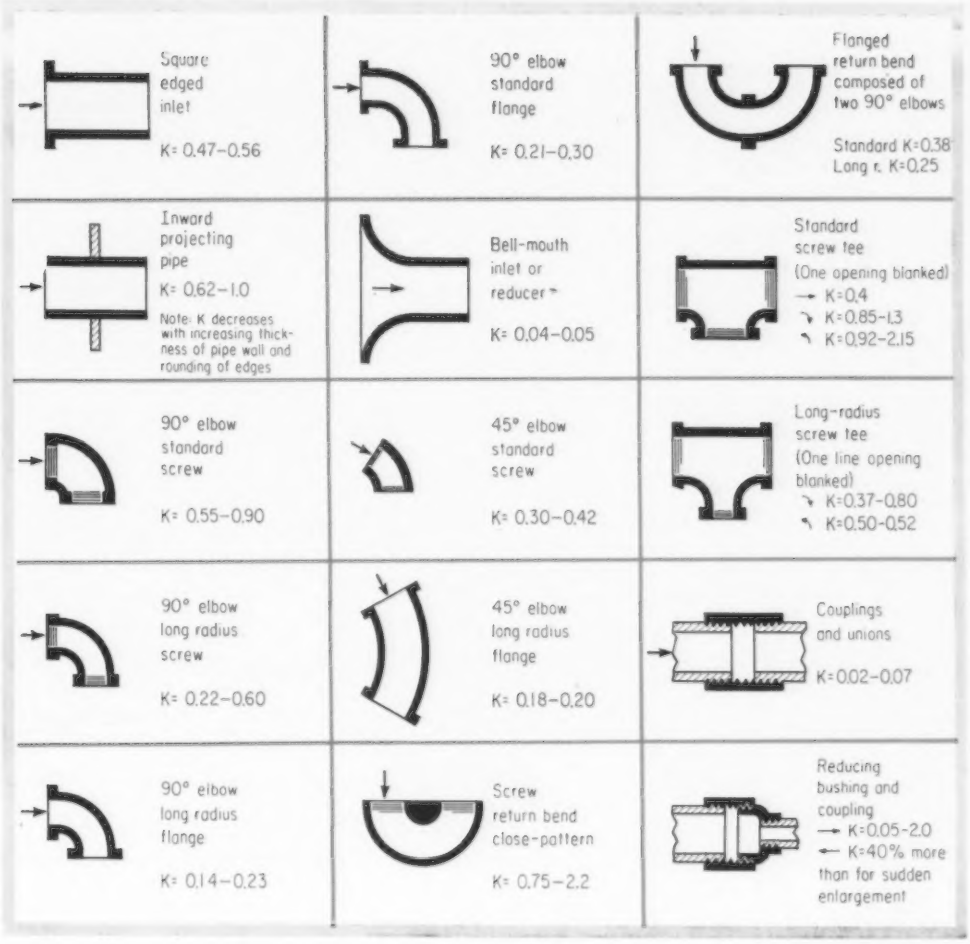


Values of *K* . . .
have been determined for these standard fittings. For special fittings, use value from type most similar.

are known, assuming upstream temperature, pressure and area are given.

One advantage here of a nomogram is that the effects of small changes in each variable can be quickly evaluated—helpful when trial-and-error solutions are required.

Components exhausting to the atmosphere can be analyzed with these curves too; downstream pressure is then assumed to be 14.7 psia.

ADDING *K*-FACTORS

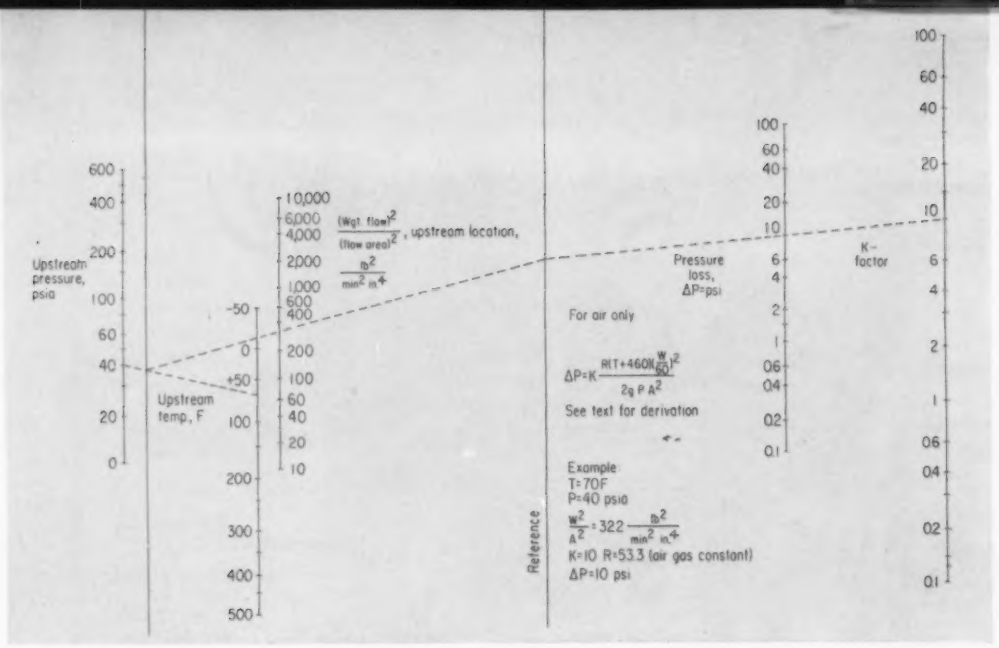
When several components are in series, it becomes tricky to figure individual pressure drops, because each cannot be calculated until the others are known—a vicious circle. A trial-and-error procedure, sometimes very lengthy, is to assume values of flow, figure pressure drops, then recheck the flow.

K-factors can be added directly, however, if the density variation through the system is small and the ducts are same size. Different sizes of ducts can be compensated for by choosing a reference area and multiplying all *K*-values by the ratio of the square of the reference area to the square of the actual duct area. Select most common duct area for the reference.

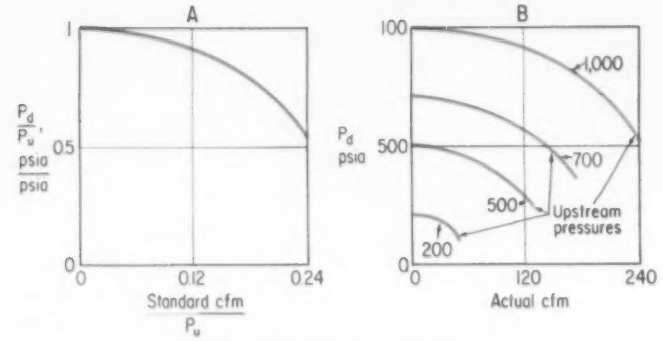
COMPLICATED BY THE SPEED OF SOUND

If the approach velocity is kept below ¼ speed of sound (Mach 0.25) the compressibility effects of air are negligible and the *K* factor will accurately predict losses.

A hazard in computation is "choking." Critical pressure ratio across a flow restriction ($P_d/P_u = 0.528$) results in sonic velocity at the restriction. Further reduction in downstream pressure P_d does not increase the flow, because sonic velocity is the maximum that will occur at the throat. This limiting action is called choking, and data taken under such circumstances must be handled differently. When the pressure ratio is 0.528 or below, the throat pressure P_t is $0.528P_u$, and therefore the ΔP for determining *K* is $(1.0 - 0.528)$ $P_u = 0.472P_u$. **(continued on next page)**



Quick calculation . . .
of pressure losses for any component can be made if any two of three variables is already known: pressure loss, air flow, K-factor. It works for other gases too if correction for *R* is made.



OTHER WAYS TO FIGURE ΔP

It is difficult to make a rigorous theoretical calculation of pressure drop in components because several types of resistance (such as friction, orifice, obstruction, bend) are involved. Each requires a separate mathematical approach. Here, all pressures and temperatures are assumed absolute; standard cfm means actual flow adjusted to flow at 14.7 psia, 60 F; weight density is used.

Friction for turbulent flow in straight lengths of pipe tends to obey the Darcy-Fanning equation:

$$\Delta P \propto f \frac{(\text{length})(\text{density})(\text{veloc.})^2}{(\text{dia})2g}$$

where f is the "friction factor," a function of Reynolds number, but none-theless empirical. Laminar flow complicates it by introducing viscosity:

$$\Delta P \propto \frac{(\text{viscosity})(\text{length})(\text{veloc.})}{(\text{dia})^2}$$

Orifice-type obstruction can be handled by this "simplified" equation from Marks' Handbook:

$$\text{Wgt. flow} \propto C_D A_2 P_2 \sqrt{(1/T_1)(1+Y)Y}$$

where C_D is the coefficient of discharge, A_2 is the equivalent orifice area, P_d is orifice pressure, and Y is $(P_1/P_2)^{0.286} - 1$.

Bends can be treated like straight pipe, but with a special empirical constant C_B that is a function of length, dia, and bend radius:

$$\Delta P \propto C_B \frac{(\text{density})(\text{veloc.})^2}{2g}$$

Simple empirical equation is apparently needed. The constants must be obtained experimentally because valves and fittings are too complex for classical analysis. For example, one company offers an over-all "flow factor" for estimating ΔP:

$$\Delta P \propto \left(\frac{1}{C_V}\right)^2 \frac{(\text{volume flow})^2\,(\text{avg. temp.})}{(\text{downstream pressure})}$$

where C_V represents volume flow for 1 psi across the restriction, and is tabulated for certain valves and fittings.

Some prefer this author's method, using an over-all "resistance" constant:

$$\Delta P \propto K \frac{(\text{density})(\text{veloc.})^2}{2g}$$

where K is measured in "velocity heads" of the fluid flowing. Others assume that pressure drop is caused by an "equivalent length of straight pipe measured in diameters."

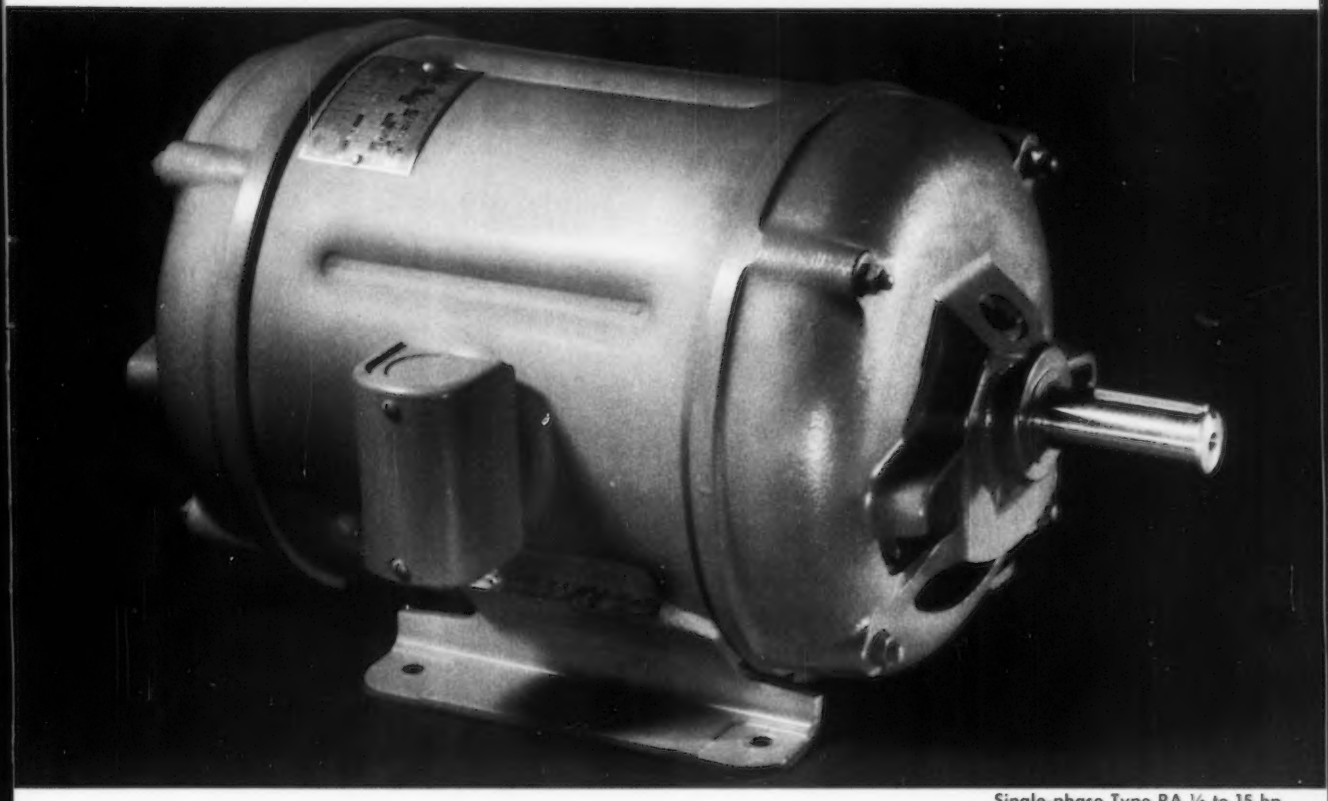
Curves at left (see "Pressure Drop in Pneumatic Components and Systems," 1955 Annual Handbook, p J2) show that:

$$\text{volume flow} \propto C_K \sqrt{P_u^2 - P_d^2}$$

where C_K depends on passage configuration, friction, and inlet temperature. It is more convenient to plot P_d/P_u vs (standard cfm)/P_u because experiment has shown that the resulting "characteristic curve" will be unique for the component under study, and comes out the same for whatever pressure level is selected. This means that only one test point is needed to calculate curve A; and curves *B* are derived from curve A.

EDITOR'S NOTE: **Pressure-flow performance of hydraulic components is discussed with theory and examples in "Pressure-drop Calculations," June '54, p 197.**

Got a Real Tough Starting Problem ?



Single-phase Type RA ½ to 15 hp.

Wagner Repulsion-Start Induction Motors start heavy loads with low current

The Wagner Type RA is the work-horse of the single-phase motor field. It combines high starting torque for quick, easy starts with low starting current and minimum light flicker. It has a constant high operating speed, even under overload, and a flat efficiency curve over a wide operating range.

You practically eliminate service problems when you power tough single-phase applications with Wagner RA Motors. They have unmatched ability to start high inertia or heavy friction loads repeatedly and they give many years of unfailing service.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Bulletin MU-220.

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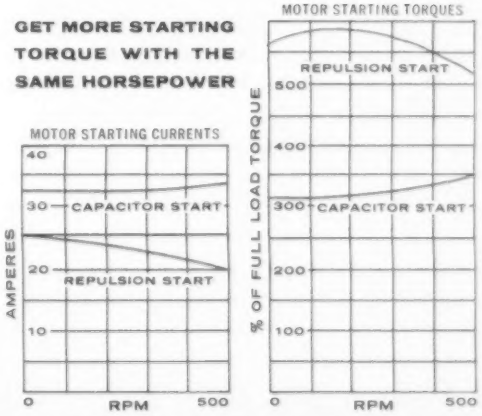
GET MORE STARTING TORQUE WITH THE SAME HORSEPOWER



ONE HP, 1750 RPM, 60 CYCLES, 230 VOLTS

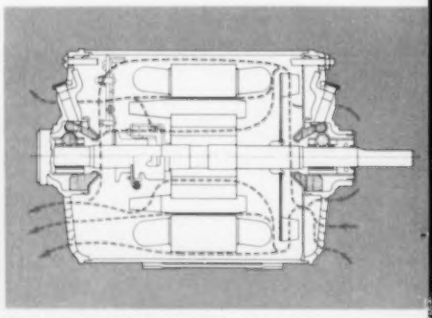
Integral Ratings, 1-5 hp are available in the latest NEMA Frame Sizes

H. P.	OLD FRAME SIZE	PRESENT FRAME SIZE
1	203	182
1½	204	184
2	224	213
3	225	215
5	254	254U

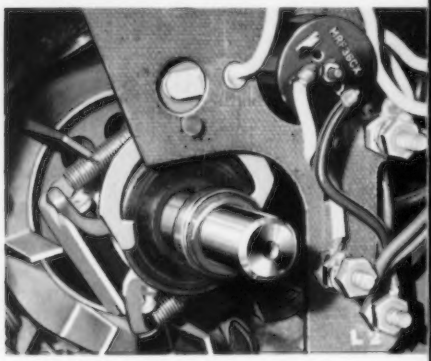
4 pole (1750 RPM, 60 cycle and 1450 RPM, 50 cycle) ratings are interchangeable in mounting dimensions with capacitor start motors of the same ratings.

Got a Normal Starting Application?

Single-phase
Type RK
⅙ through 5 hp.



EFFICIENT COOLING SYSTEM—The improved ventilating system used in these motors directs a large volume of air through the motor to effectively reduce temperatures and add to motor life. Cross section above indicates direction of air flow.



QUICK BREAK SWITCH—The starting winding and capacitor are disconnected from the line by this Wagner Switch—test-proved to make more than a million makes and breaks . . . the equivalent of two starts per hour for 50 years.

WAGNER CAPACITOR-START MOTORS provide dependable starts... long troublefree life

Here's the single-phase general purpose motor that gives more horsepower with less bulk—is rugged enough to permit direct mounting, compact enough to fit in tight spots. Available with sleeve or ball bearings — with rigid bases or with resilient mountings for exceptionally quiet operation.

ALL-ANGLE OPERATION

The sleeve bearing design in fractional hp ratings, has a positive lubrication system that permits operation in any position. All angle mounting can mean important savings in initial costs to manufacturers—can help the design engineer in a tight spot.

You can get these motors from leading motor distributors in your community and from Wagner Sales Offices in 32 principal cities. Your Wagner Sales Engineer will be glad to help you select the right motor for your application. Wagner Bulletin MU-217 gives full details.

MYLAR® INSULATION — Mylar-paper laminated slot insulation gives top protection against moisture, adds thermal stability, to give more application versatility and longer life when unexpected overloads occur.

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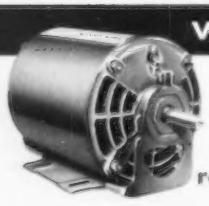
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

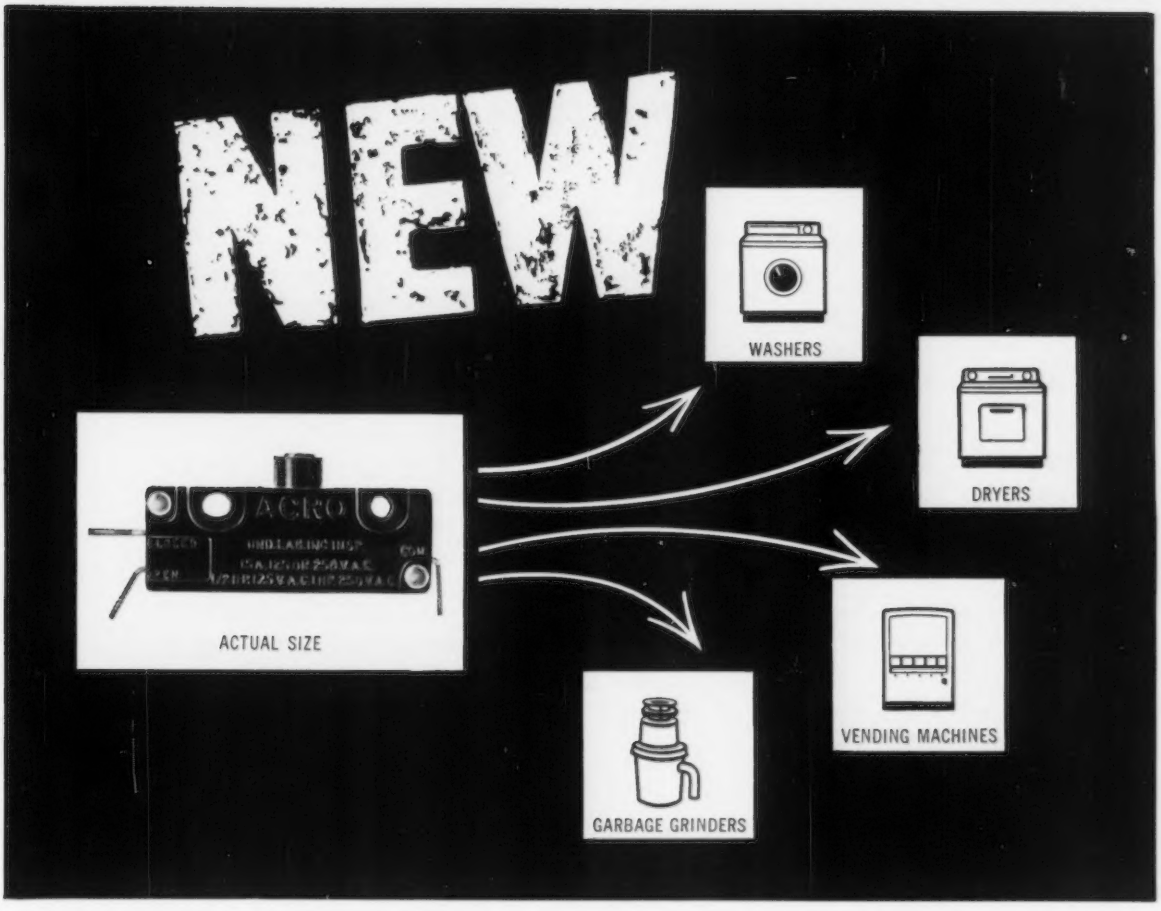
WAGNER "48" SPLIT PHASE MOTORS . . . 1/6, 1/4, 1/3 hp.



for low starting torque requirements

If you need a small fractional horsepower motor for use on fans and blowers or on a wide variety of easy-to-start machines and appliances, you can't beat the Wagner "48" Type RB Motor. It offers all the advantages of the Type RK described above, with the exception of high torque capacitor starting. This smaller, lighter, limited use motor can solve many application problems economically.

WM58-8



LOW-COST, HIGH QUALITY ACRO APPLIANCE SWITCH

ACRO LIQUID LEVEL SWITCH FOR APPLIANCES

Dependable control of water level in automatic washers anddishwashers, and liquid level in beverage dispensers and similar equipment is assured by this sensitive ACRO control device. Pressure changes in the fluid (or air) to be controlled, are transmitted to a pressure compartment, which causes a diaphragm to actuate a snap-action switch.

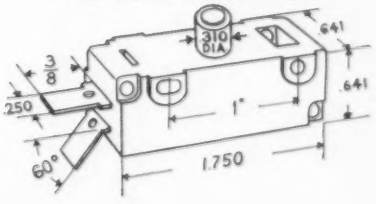
- Factory calibration to close tolerances
- Wide range of operating pressures
- Underwriters labeled 20 amps., ½ HP, 115-230 v A.C.
- Unaffected by overloads to 60 psi
- Corrosion-resistant
- Available as multi-level or single level control.

WRITE FOR DATA SHEET

- **Precision snap-action switch (rolling spring type)**
- **½ horsepower rating 125 v A.C.**
- **Compact design**
- **Spade terminals**
- **Silver contacts**
- **Beryllium copper spring members**

You can't buy a higher quality or more dependable door or control switch for appliances than this new ACRO Appliance Switch. Yet ACRO's modern mass production techniques make it available to you at a *really low price*. ACRO rolling spring principle assures "bounce-free" snap action and longer life.

WRITE FOR DATA SHEET



Robertshaw-Fulton CONTROLS COMPANY

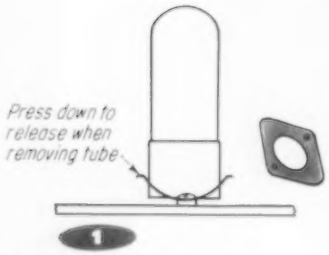
ACRO DIVISION • Dept. 252, Columbus 16, Ohio

12 WAYS to RETAIN ELECTRON

with their advantages and disadvantages

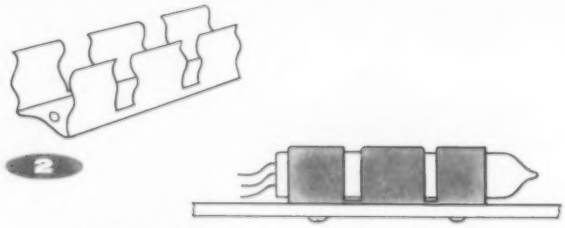
Advantages are in boldface—
Disadvantages are in italics

Finding ways to hold electron tubes in their sockets is a problem that is often left to the mechanical designer rather than the electronic-circuit designer. Most holding devices in this survey are available for purchase.



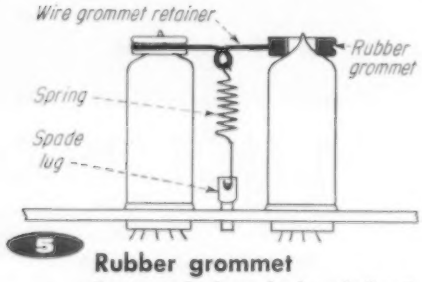
Bowed spring collar

Inexpensive
Simple to install
Not applicable to military equipment
Requires hand room to release clamp-action



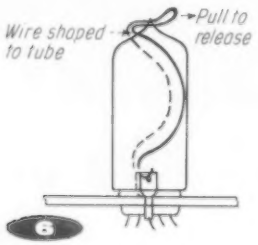
Spring clamp

Available in variety of styles and sizes
Dissipates heat from tube to chassis
Meets military specifications
Takes up much horizontal space



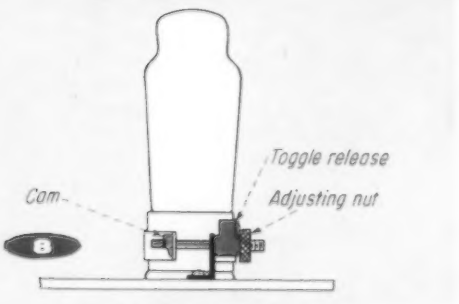
Rubber grommet

Protects tube from shock and vibration
Inexpensive
No loose parts to handle
Must be used with two equal-height tubes



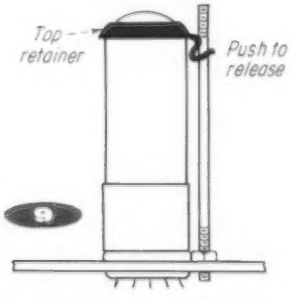
Formed wire

Inexpensive
Releases from top
Cannot be used on military equipment



Base cam-clamp

Meets military specs
Adjustable to different base diameters
Must be located for toggle accessibility

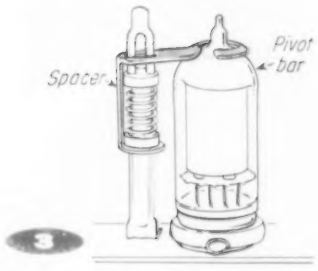


Top retainer

Available in variety of styles and sizes
Inexpensive
Meets military specs
Retainer is loose part when tube is removed

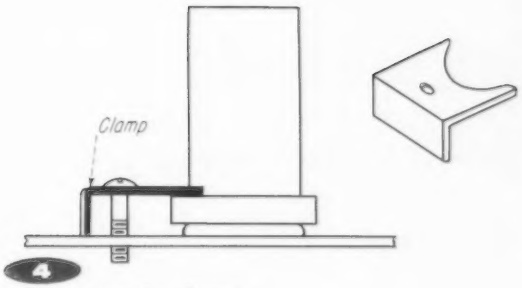
TUBES

FRANK WILLIAM WOOD Jr.,
Design Engineer
Servonics Inc.,
Alexandria, Va.



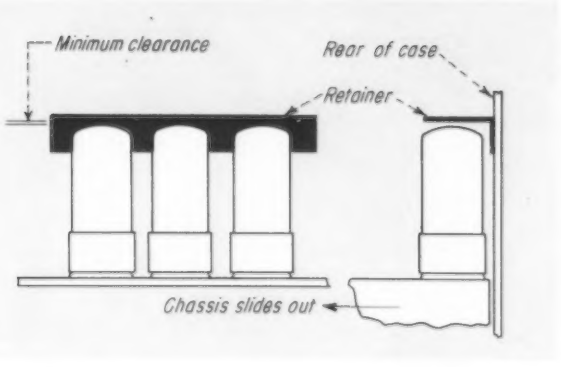
3

Pivot bar
Releases from top
Can easily accommodate different tube heights
Occupies valuable chassis area



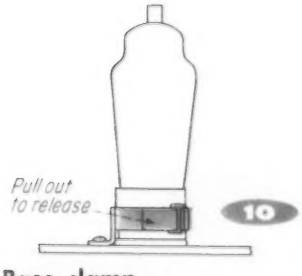
4

Angle clamp
Inexpensive
Suitable for military equipment
Screw must be completely removed before removing tube
Occupies much chassis area
Limited to small variety of tubes



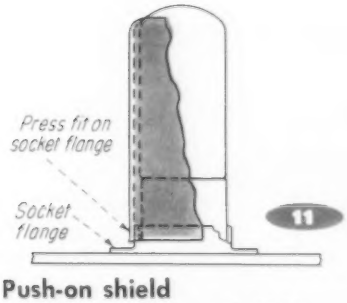
7

Built-in retainer
Eliminates necessity of individual retainers
Saves time when troubleshooting
Applicable only to line of tubes along side or rear of chassis



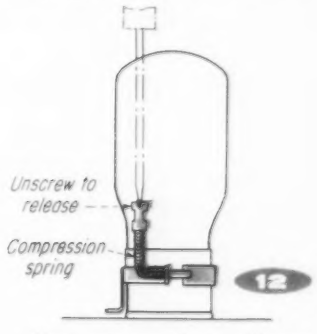
10

Base clamp
Meets military specs
Available in variety of sizes
Takes up much chassis area
Release space required around tube



11

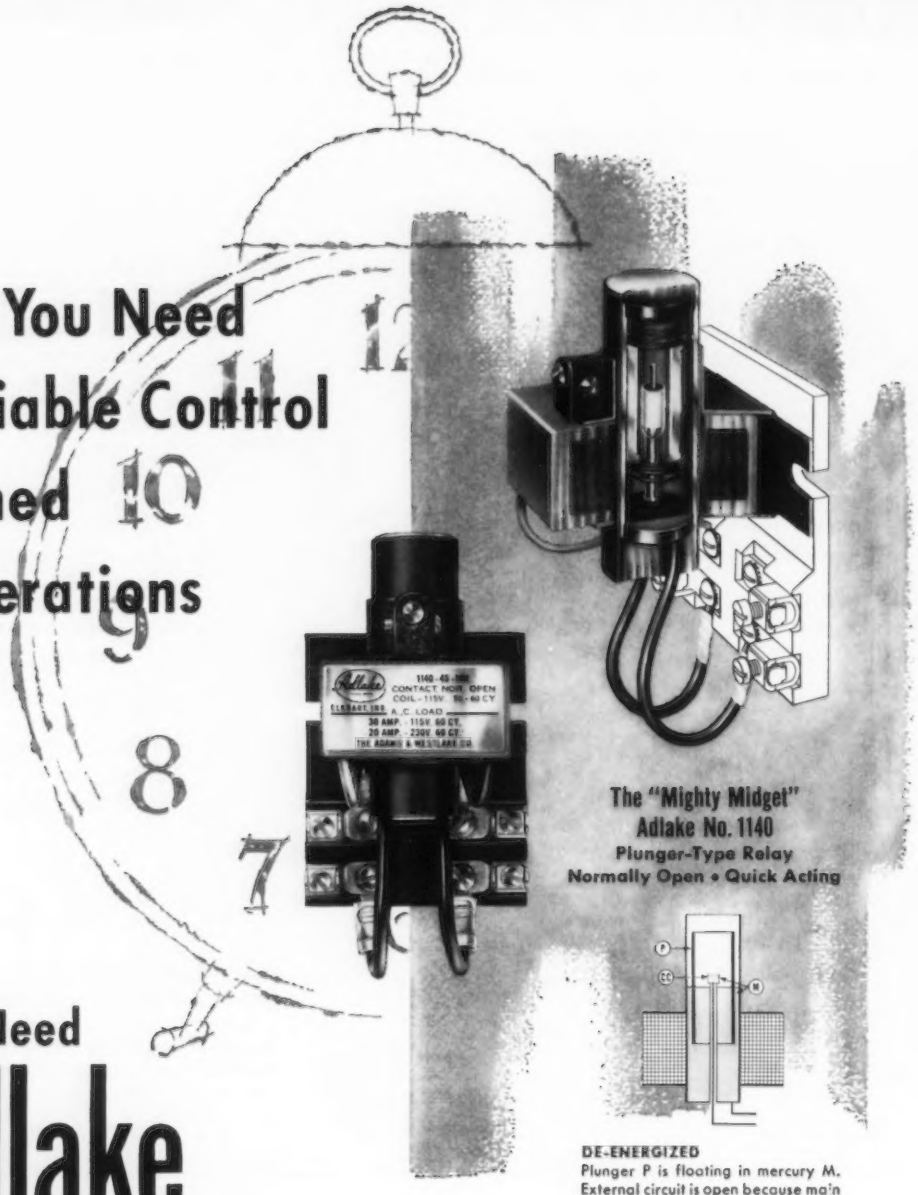
Push-on shield
Combination retainer and shield
Occupies no extra chassis area
No positive retention
Not applicable to military equipment



12

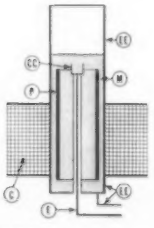
Top-release base clamp
Available for purchase
Operates from top
Screwdriver required

When You Need Reliable Control Of Timed Operations



The "Mighty Midget"
Adlake No. 1140
Plunger-Type Relay
Normally Open • Quick Acting

DE-ENERGIZED
Plunger P is floating in mercury M. External circuit is open because main body of mercury M is below lip of ceramic cup CC.



ENERGIZED
Coil C pulls plunger P down into mercury M. Mercury thus displaced completely covers ceramic cup CC filled with mercury. This establishes mercury-to-mercury contact between electrodes E and EE.

You Need

Adlake

mercury-to-mercury relays

List what you like and don't like in a switch, then see how Adlake meets your need:

- **Immune to vibration**
- **Perfect snap-action—no burning, pitting or sticking**
- **No intrusion of dust, dirt or moisture—hermetically sealed at the factory**
- **Time delay characteristics fixed and non-adjustable**
- **Quiet. Chatterless. Require no maintenance whatever.**

Our engineers will gladly help you with your control problems. No obligation. Just write the original and largest maker of plunger-type relays—THE ADAMS & WESTLAKE COMPANY, 1169 N. Michigan, Elkhart, Ind. • New York • Chicago

SHRINK-FIT NOMOGRAPH

For steel and cast-iron rings of equal length.

SIGMUND RAPPAPORT,
Project Supervisor,
Ford Instrument Co.,
Long Island City, N. Y.
Adjunct Professor of Kinematics,
Polytechnic Institute of Brooklyn

SYMBOLS

A = mating-surface area, in.²
E = 30,000,000 psi for steel
= 15,000,000 psi for cast iron
P = desired transmitted force, lb
p = pressure of mating surfaces, psi
S_f = safety factor
σ = max. resultant stress, psi
ϵ = relative shrinkage, mils per in.
μ = friction coefficient

STEP 1

Find ϵ/p (1000) from nomograph A for whichever combination of steel and cast iron is being considered. In the construction shown this is 0.175, for case 1 (both rings made of steel).

STEP 2

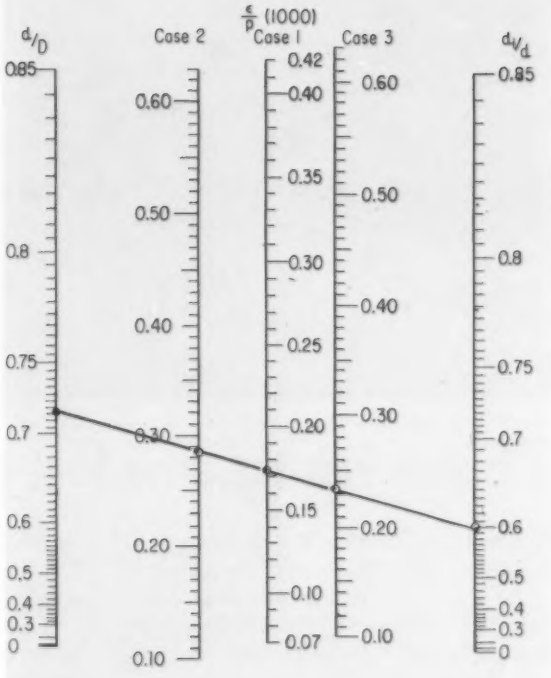
It is then necessary to find p. This is found from

$$p = PS_f/A\mu$$

It's value must be high enough to allow the desired torque to be transmitted safely. This torque may be that required to drive a shaft; or it may be merely a test requirement for a

(Continued on page 87)

Nomogram A



Auxiliary nomograph . . .
has scales for different combinations of cast-iron and steel rings.
Case 1: Both rings steel.
Case 2: Outer ring cast iron, inner ring steel.
Case 3: Outer ring steel, inner ring cast iron.

US RUBBER **PowerGrip** "TIMING" BELT

Put reliance on this low-cost belt for your appliance

See the "U. S." exhibit
ASTE Show
Booth 1233

SAVE the "Timing" Belt permits use of a smaller, lower-cost motor

SAVE the "Timing" Belt is reliable—it always works

SAVE with simpler design and fewer units

SAVE it reduces assembly costs

The appliances equipped with PowerGrip "Timing" Belt include:

Air conditioners
Electric typewriters
Lawn mowers
Power tools
Dryers
Washers
Portable tools
Sewing machines
Polishers
Waxers
Sanders

New efficiency with the drive built specifically for appliances

The U. S. PowerGrip "Timing"® Belt has an efficiency of close to 100%. That's why the makers of many kinds of appliances can now combine simplicity of design with split-second response. PowerGrip has no slippage, no take-up—allows short and fixed centers, high ratios. No need for lubrication or housing devices, because there is no metal-to-metal contact. *Quiet!* Handles speeds up to 16,000 f.p.m. or so slow as to be imperceptible to the eye. *Vibrationless!* Simplify and improve your power transmission unit with U.S. PowerGrip "Timing" Belts.

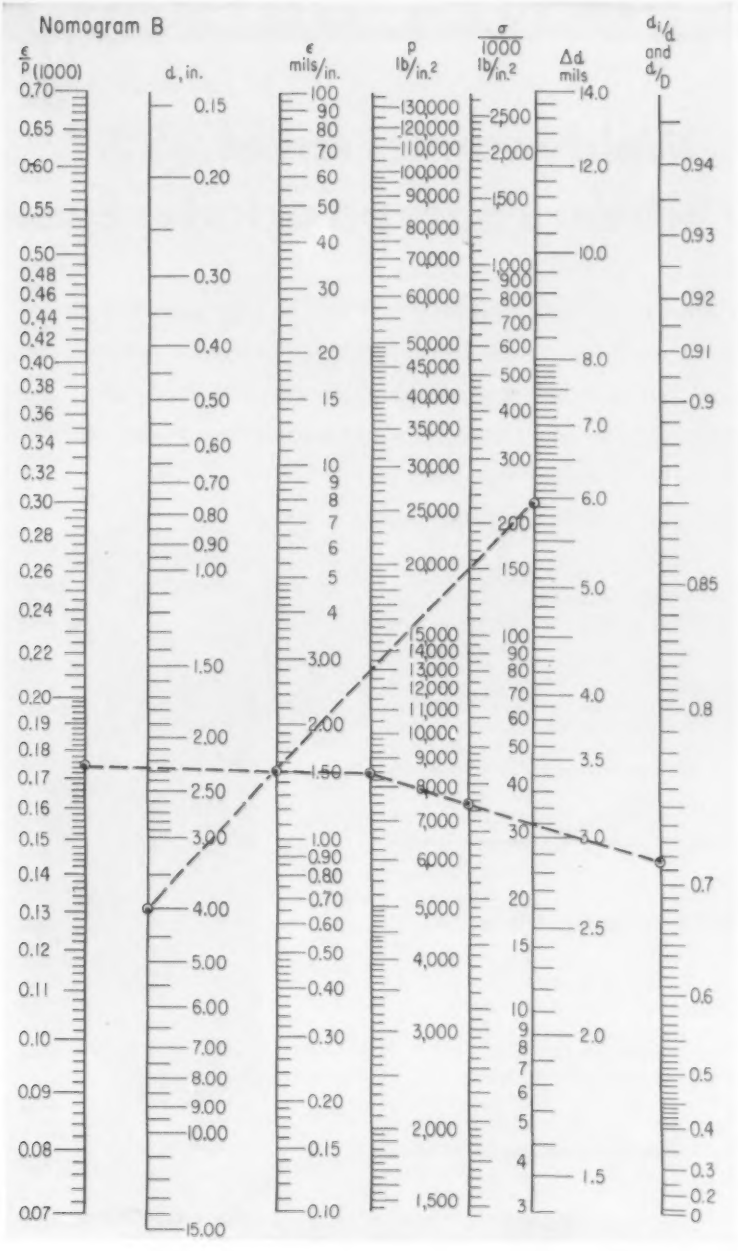
These unique transmission belts are available, along with expert engineering service, at your "U.S." power transmission distributor, or by writing us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

US RUBBER **Mechanical Goods Division**

United States Rubber

See things you never saw before. Visit U. S. Rubber's new Exhibit Hall, Rockefeller Center, N.Y.

SHRINK-FIT NOMOGRAPH (cont'd)



Digested from an article by F. Florin in Konstruktion, No. 9 (1957), published in Germany.

static structure such as a shrunk flange used as a support.

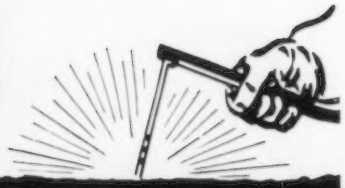
STEP 3

Enter p in the B nomograph at the value found from above formula. (8500 psi in the sample construction.) Connect this value with the previously found ϵ/p (1000) value, 0.175. At the point where this line cuts the ϵ scale draw a secant from the d scale ($d = 4$ in. in sample.) This line cuts Δd at 0.006 in. The rings would, therefore, be machined to have a 0.006 in. interference on the mating diameter.

MAX STRESS . . .

will occur at the bores for either ring. The ring with the larger diameter will have the larger max stress. It is better to choose diameter-ratios such that the strength of both rings is fully employed—even if the rings are made of different materials. Ninety percent of yield point is considered permissible for σ. In the sample nomograph, σ has a value of 35,000 psi, obtained by drawing a secant through $p = 8500$ and $d_i/d = 0.715$. Since the yield point for the steel is about 40,000 to 50,000 psi, the value for σ thus found would be satisfactory.

Weldynamics



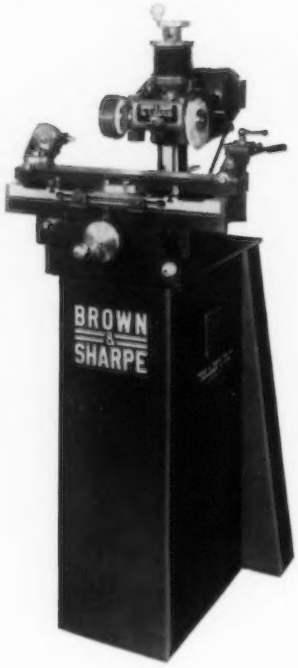
ARC WELDING AT WORK CUTTING COSTS

Weldynamics saves 38% on Brown & Sharpe grinder base

A more rigid, better looking machine at 38% less cost—thanks to Weldynamics. In redesigning the former welded construction, details were simplified to use preformed parts. Welds are now more accessible and made faster. Parts can be machined before assembly, reducing storage and handling costs.

Original design in welded steel had to be assembled before machining causing increased handling and storage costs.

New design of welded steel weighs less, costs less and looks better. Components are simple and machining is completed before assembly. All welds are easily made and finishing costs held to minimum.



How to put **WELDYNAMICS** to work for you

Direct consultation with Lincoln men, trained in Weldynamics, to help you with procedures, and to recommend the proper machines and electrodes—Product Design Seminars conducted to help you design correctly in welded steel—Design Bulletins, sent free to design engineers and production supervisors, offer design ideas—Procedure Handbook, contains over 1300 pages, 240 devoted to machine design practices. $3.00 postpaid in U.S.A., $3.50 elsewhere. Write us.

The World's Largest Manufacturer of Arc Welding Equipment

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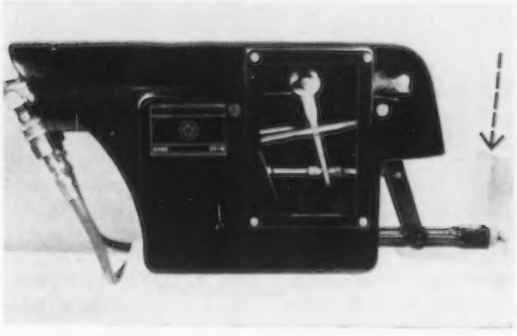
THE LINCOLN ELECTRIC COMPANY, DEPT. 1327, CLEVELAND 17, OHIO

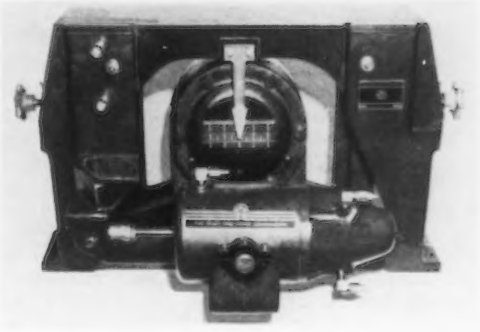
NEW COMPONENTS and MATERIALS

PHOTOELECTRIC COUNTER . . .

has transistor amplifier and separate light source. Counter, which can be reset, is directly coupled to cell, eliminating customary intermediate relay. Housings are die-cast aluminum, with waterproof cable inlets—system is designed to operate in high ambient light, as much as 8 ft apart. Counting speed is up to 1000 per min, operating voltage 110-250 v, 50 or 60 cps, ac. Light source and amplifier are each 3.5 x 4.75 x 5.25 in. long. US price range of this English-built equipment is $80-100 each; delivery 6-8 wk after receipt of order. **Counting Instruments, Ltd., Sheffield, Mass.**

Circle 1, inside back cover





PNEUMATICALLY OPERATED WEB CONTROL . . .

is based on palm-like element (on left, above) in constant contact with textile, paper, plastic or other material being processed. When material moves out of position on guide roll, air signal actuates mechanism (right, above) which positions roll. System can be automatic or controlled from a remote, manual-visual control station that is available. Motion transmitter can operate over 4-in. guide-roll travel. Max required air supply, tapped from the plant supply, is 95 psi. Price ranges from $2000-5000; delivery from stock. **Pusey & Jones Corp., Wilmington 99, Del.**

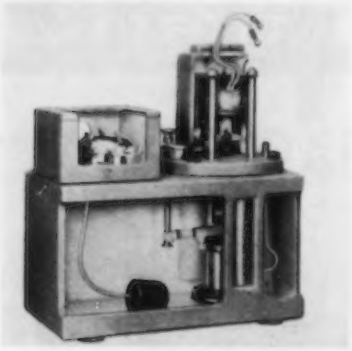
Circle 2, inside back cover

HIGH-TEMPERATURE FLUOROCARBON RUBBER . . .

is resistant to oils, fuels and solvents at temperatures above 400 F (see PE, Mar. 24,'58, p. 7). This rubber is a linear copolymer of vinylidene fluoride and hexafluoropropylene; it contains about 65% fluorine by weight. Resistance to heat aging is rated at better than 2400 hr at 400 F, 24 hr at 600 F. At room temperature, tensile strength is about 2000 to 3000 psi; ultimate elongation varies from 100 to 400%, depending on hardness. At 300 F, tensile strength runs 300 to 1000 psi and elongation 80 to 200%. Though the rubber loses tensile strength and elongation at elevated temperatures, it reportedly can be compounded to have hot tensile strength and elongation equal to any elastomer and better than most. Stocks of the rubber have good resistance to compression set. Specimens compressed 25% and held 70 hr at 250 F will recover to within 90 to 97% of original dimension. Applications include valve-stem seals, brake cups, front pump seals in automatic transmissions, gasoline pumps, thermostat bellows, fire walls, and roll coverings. It can also be used in jet engines and other high-temperature equipment. The synthetic rubber is shipped as a gum polymer in 50-lb fiber packs for compounding with other ingredients and fabrication into end products. Raw polymer sells for $15 per lb. **E. I. duPont de Nemours & Co., Deepwater Point, N. J.**

Circle 3, inside back cover

CONTINUED ON PAGE 90



Solenoid-operated lubricator . . .

is adaptable for manual, automatic or remote control. Available with 3 or 6-pt reservoir. Automatic warning systems are provided with larger reservoir. One warning is operated by a single-contact float switch that sets off a visible or audible alarm when oil supply is low. Another, operated by a double-contact switch, gives alarm and then if oil is not added within a short time, automatically shuts down machine before all oil is gone. A pushbutton or foot switch may be used for manual control. Machine circuit or a contact or microswitch governed by the machine cycle provides integrated automatic control. Volume, determined by the piston stroke setting, varies from 6 drops to 24 drops per cycle. As many as 20 average bearings may be lubricated by a single unit. Lubricator is rated for 6 million cycles. **Bijur Lubricating Corp., Rochelle Park, N. J.**

Circle 4, inside back cover

Electronic counting package . . .

includes a high-speed magnetic counter in a steel case, a light source and a photo cell. Rated speed is 3000 counts per min. Photo cell can be made in any configuration to suit any application. Cell and light source are permanently assembled so that vibration will not jar them out of focus. A ¼-in. object or space moving at 6000 fpm will actuate. Interruptions of variations of a direct or reflected light beam may be utilized. Unit utilizes transistors and printed circuits. Pilot light, reset button and power switch are mounted on the panel. **Electronic Controls Div., Veeder-Root, Inc., Hartford 2, Conn.**

Circle 5, inside back cover

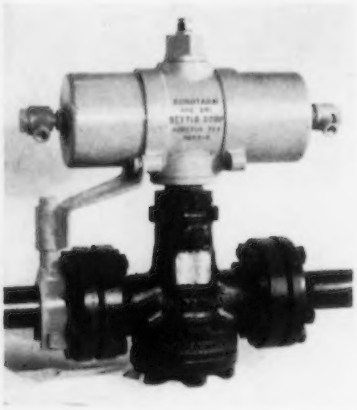
Microminiature relay . . .

is hermetically sealed for use in printed-circuit equipment. The DPDT, dc relay is an improved version of the G-200 micro relay. It is tailored to the new grid-spaced concept in printed-circuit layout. Has coil resistance of 600 ohm for 26.5-v-dc circuits and will operate over a 190°-ambient-temperature range from —85 to 257 F. Relay has contact rating of 3 amp resistive at 28 v dc or 115 v ac for 100,000 operations and a rating of 2 amp resistive load at the same voltages for 500,000 operations. Unit weighs about ½ oz and measures 0.4 x 0.80 x 0.875 in. Operating time with normal voltage applied to the coil is 4 millisec nominal; release time is 2.5 millisec nominal. **General Electric Co., Schenectady 5, N. Y.**

Circle 6, inside back cover

Actuator for plug valves . . .

and other 90° rotating mechanisms is gas or fluid-operated. Incorporates a totally enclosed piston rack and gear assembly fully submerged in an oil bath. Can be placed over and adapted to average plug-valve stem. Valve operation is not disturbed and special tools are not required. Standard parts include combination adjustable stops, valve-stem adaptor bushings and valve lubricator extension fitting. Accessories include pneumatic or solenoid-operated pilot valves. Standard models



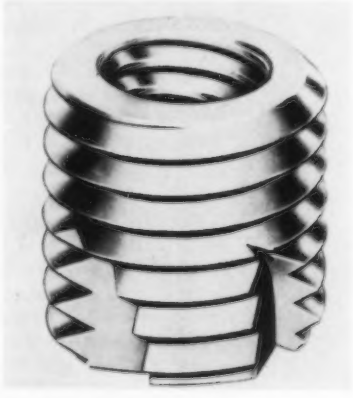
generate torque output from 3000 in.-lb to 25000 in.-lb with 100-psi operating pressure. **Bettis Corp., Houston, Tex.**

Circle 7, inside back cover

Combination flow regulator . . .

has built-in relief valve. Can be used as a high-capacity relief valve, as a remotely operated relief valve, to replace a pump for power steering or to provide small flow for a control system. The combination bypass and restrictor-type flow regulator eliminates piping and fittings normally used to include a relief valve. Less complicated circuitry permits compact design and reduced costs through dual usage of the valve housings. **Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.**

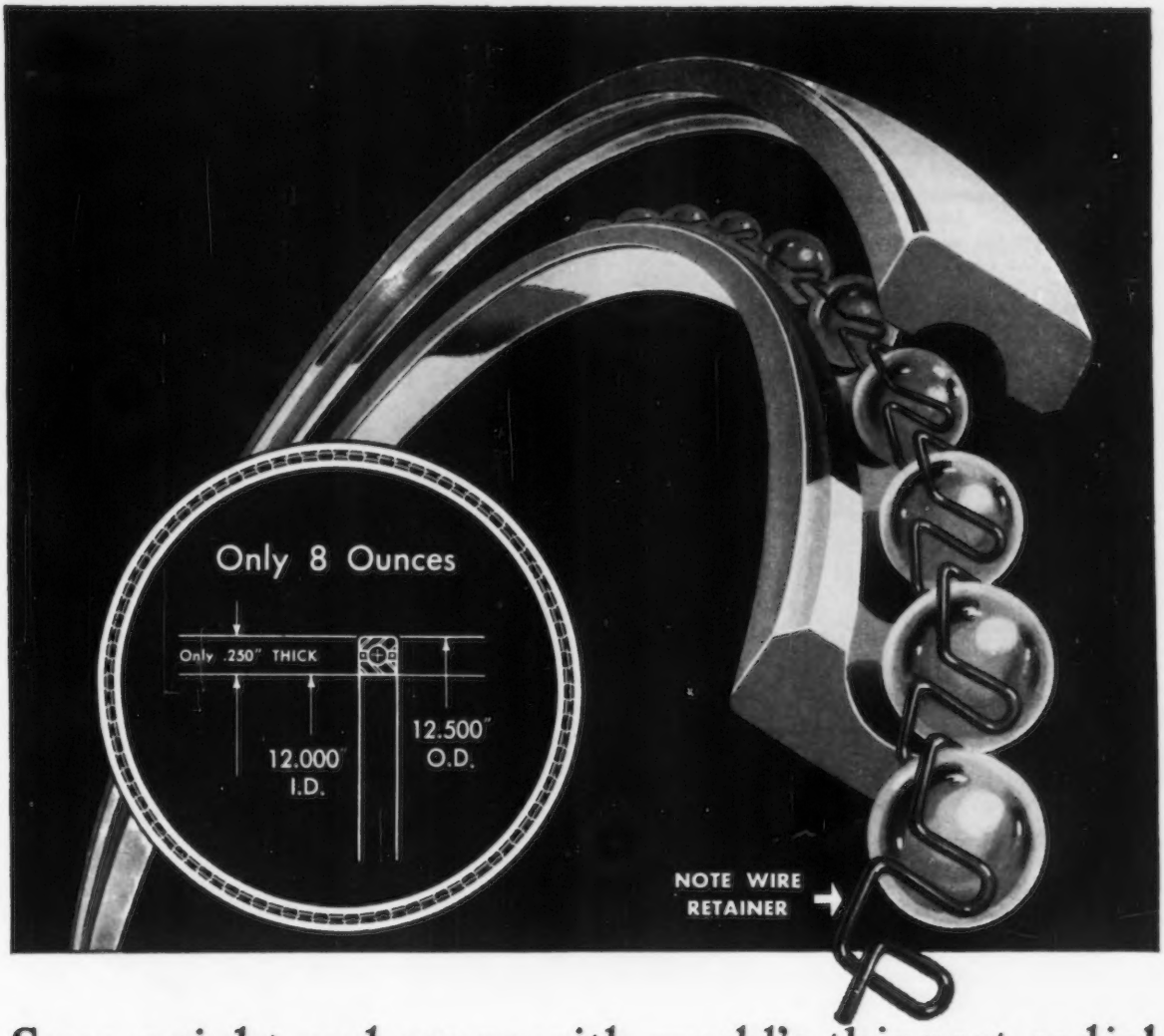
Circle 8, inside back cover



Self-tapping insert . . .

with four cutting edges cuts its own thread as it is rotated into a cored or drilled hole. Cutting edges provide adequate chip flow and prevents chips from entering internal

CONTINUED ON PAGE 92



Save weight and space with world's thinnest radial ball bearings—*Reali-Slim* by Kaydon

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from 9/16" and in bore diameters from 5" to 40".

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

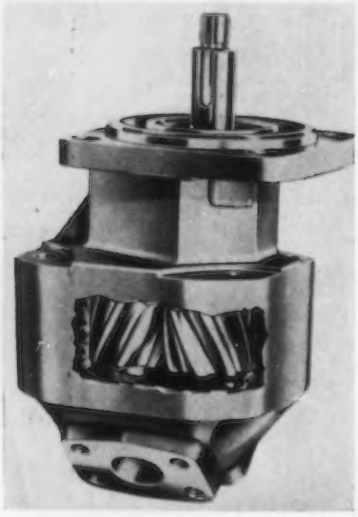
K-561

All types of ball and roller bearings — 4" to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Needle Roller • Ball Radial • Ball Thrust Bearings

thread. Designed for installation into aluminum and magnesium alloys and plastics to provide a steel thread in these softer-than-steel materials. Protects against stripped threads. Inserts are cadmium-plated carbon steel, stainless steel or brass. **Newton Insert Co., 6500 Avalon Blvd., Los Angeles 3.**

Circle 9, inside back cover



High-speed hydraulic pump . . .

has gears with an elliptical profile that eliminates trapping of liquid between teeth. The non-trapping feature permits speeds in excess of 4000 rpm with hydraulic pressures of more than 1500 psi. Flow rates from 3 to more than 250 gpm are available. Ability to operate at high speeds eliminates gearing accessories on hydraulic applications. **Hupp Aviation Co., Div. of Hupp Corp., 6633 W. 65th St., Chicago 38.**

Circle 10, inside back cover

Manual four-way valves . . .

for 0-to-250-psi air and oil service incorporate a design that prevents both internal and external leakage. Valves presently in production are available in standard three-position models and models with spring-return to either center or reverse position. Offered in $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$-in. NPT pipe sizes. Min flow passage ranges from $\frac{3}{8}$ to $\frac{29}{64}$ in. dia and rated flow is 20 ft per sec, ranging from 7 to 15.5 gpm, according to port size. Mechanical parts are stainless steel and aluminum. Since original-equipment manufacturers do not normally require a mounting bracket and prefer to

paint the complete power unit after assembly, the mounting bracket and finish have been eliminated. Ball-type handle replaces lever-type handle of previous models. **Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58.**

Circle 11, inside back cover

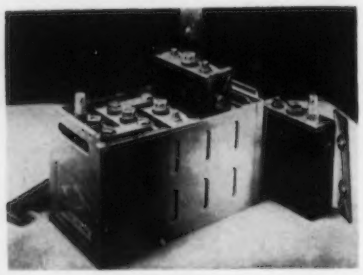
Hollow-shaft motor reducer . . .

permits direct-coupling to equipment by inserting the drive shaft of a machine. Can be mounted in limited spaces, in most positions. Right-angle worm reducers are available with standard single-speed motors or in various power packages incorporating magnetic brakes, slip ring, two-speed and fluid-shaft-drive motors. Offered in $\frac{1}{2}$ through 2 hp with 13 gear-reduction ratios from 18 through 250 rpm. Hollow shaft is precision-bored full length, with keyway. **Reuland Electric Co., Alhambra, Calif.**

Circle 12, inside back cover

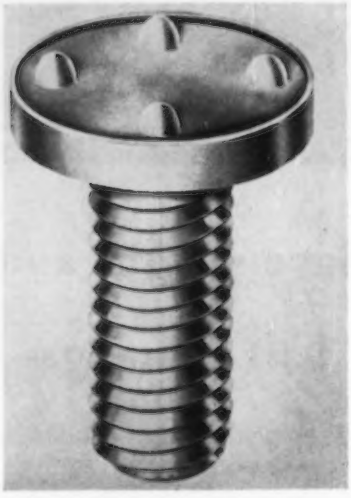
Heavy-duty batteries . . .

are said to be practically indestructible mechanically and electrically. These nickel-cadmium batteries, which operate in temperatures down to —40 F, were developed for starting gas turbines, diesel engines, off-the-road equipment and, in



general, all circuits requiring a very high current for short periods. Batteries generate currents 20 times their rated capacity. Individual steel-encased cells, with nominal voltages of 1.2 v, are assembled into steel containers to make batteries of any desired voltage. Patented plates are perforated nickel-plated steel strips on which a porous body of nickel has been sintered. Stores without preparation or special conditioning. Recharges in 6 hr. **Alkaline Battery Div., Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.**

Circle 13, inside back cover



Weld screw has rim . . .

around the periphery of screw head and has four weld projections. The rim limits, to a predetermined degree, the amount of pressure that may be applied to the projections during the fusing stage; result is the weld metal is properly diffused and confined. Head always seats flush with work. Screws are available with projections on top or on underside of head, depending on the job requirements. Screws, made of low carbon steel, are threaded to ASA Class 2A standards. Both

CONTINUED ON PAGE 94

2,000,000 DEFLECTIONS WITHOUT FAILURE.....Severe fatigue tests show Duraflex,® Anaconda superfine-grain Phosphor Bronze, permits far higher design stress

LICENSED
PROFESSIONAL ENGINEERS, MEMBERS
AMERICAN SOCIETY FOR TESTING MATERIALS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

CONSULTING ENGINEERS
THE CARLSON COMPANY
MACHINE DESIGNERS

3457 WEIDNER AVE.
OCEANSIDE, L. I., N. Y.
TELEPHONE RO 4-8181

Complete engineering and manufacturing service including design and development of special machinery, mechanical products and spring actuated mechanisms. Stress analysis, spring design, metallurgical data, heat treatment, plant layout, engineering reports, selection of materials and equipment. Tools and products.

The American Brass Company,
99 Park Avenue,
New York 16, New York.

October 25, 1957.

Gentlemen, SUMMARY OF ENGINEERING LABORATORY REPORT NO. 102557

SUBJECT: Fatigue Life Test of "Duraflex", Superfine-Grain Phosphor Bronze and Commercial Quality Grade A Phosphor Bronze spring wire.

SPECIMENS: Compression springs made from each material, were coiled on arbors to avoid tool marks. The springs had squared ends, a high pitch to obtain high stresses and were heated after coiling in boiling water for 1 hour to relieve residual coiling stresses.

CALIBRATIONS: Each spring had its physical dimensions measured with micrometers and vernier calipers and was load tested in a Comaco Elasticometer Precision Spring Testing Instrument, before fatigue testing and after each 100,000 cycles of deflection to determine loss of load, if any.

FATIGUE TESTING: A representative number of springs from each material were tested simultaneously under identical conditions.

STRESSES: The stress in the springs, including curvature correction, during the tests were as follows:

Stress at Initial Installed Position	36,600 p.s.i.
Stress at Final Deflected Position	73,200 p.s.i.
Stress Range during deflection	36,600 p.s.i.

These stresses, for endurance limit testing, are exceptionally high for phosphor bronze spring wire - far higher than those ordinarily recommended for Beryllium-Copper or Stainless Steel for such severe service and are comparable to those used for good quality Spring Steel.

RESULTS: Grade A Springs broke at average deflections of 505,700.

Duraflex Springs were still satisfactory with no appreciable loss of load at 2,000,000 deflections.

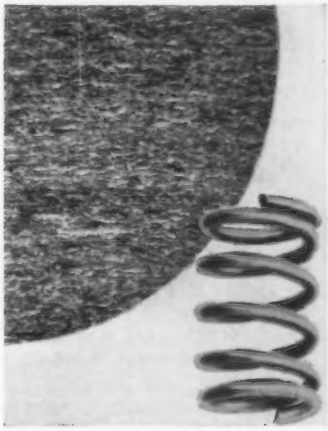
CONCLUSIONS: 1. Design stresses for Duraflex can be at least 33% higher than those used for Grade A Phosphor Bronze and as high if not higher than design stresses recommended for Beryllium Copper.

2. High endurance and long fatigue life at high stresses can be expected from springs made of Duraflex Phosphor Bronze.

CERTIFICATION: We certify the above summary of our report is accurate, in accordance with the facts and is true in every respect.

Respectfully submitted,
THE CARLSON COMPANY
Harold C. R. Carlson
Harold C. R. Carlson, P.E.
Licensed Professional Engineer.

Spring of Alloy A Phosphor Bronze, shown actual size, which broke just after 500,000 deflections. Micrograph (75x) shows typical grain structure of this metal.



Spring of Duraflex showed no appreciable loss of load after 2,000,000 deflections in same test. Micrograph (75x) shows typical superfine-grain structure of Duraflex.

Duraflex is a registered trade-mark for a higher quality phosphor bronze in sheet and wire forms, recently developed by American Brass Company research. Yet it costs no more than regular phosphor bronze. For detailed information—for a copy of the test data—write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

DURAFLEX
Superfine-Grain Phosphor Bronze
A product of
ANACONDA®
Made by The American Brass Company

...for a standard line of motors adaptable to hundreds of applications

YOU CAN ALWAYS

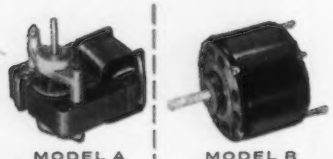
RELY on GI

Fractional H. P. Motors

1/40 H. P. to 1/1100 H. P.

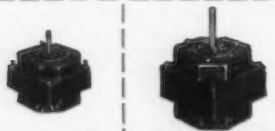
General Industries' standard line of motors is adaptable, with slight variations, to literally thousands of applications. This means that your motor requirements can most likely be met without additional time-consuming engineering.

If you are currently using fractional horsepower motors, or are planning a product that calls for their use, phone or write General Industries. We'll gladly make recommendations — without obligation.



MODEL A
2-pole, shaded pole AC Induction Type

MODEL B
4-pole, 4-coil shaded pole AC Induction Type



MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

Write for Complete Specifications and Quantity Price Quotations TODAY!

THE GENERAL INDUSTRIES CO.

DEPT. GK • ELYRIA, OHIO

types are available in dia from No. 6-32 to ⅜-in.-16 and are carried in stock in a selected assortment of lengths from ¼ to 2 in. **Parker-Kalon Div., General American Transportation Corp., Clifton, N. J.**

Circle 14, inside back cover

Disk couplings . . .

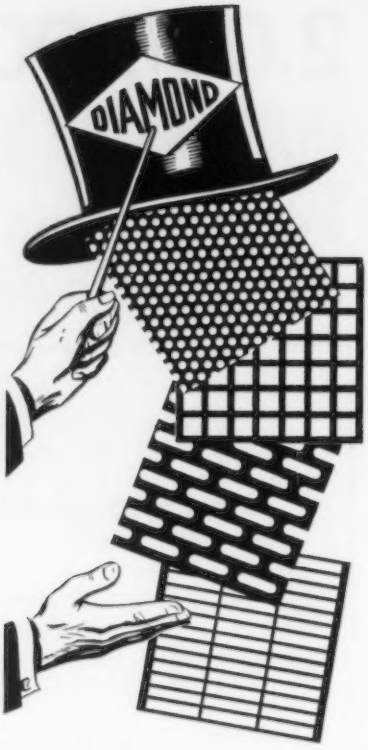
for shafts that are in angular misalignment are free of backlash, making them suitable for servo applications requiring high transmission accuracy. Coupling consists of a flexible disk riveted to a pair of precision hubs and are designed to accept ¼-in. shafting in models for clamp or pin fastening. Shafts with angular misalignment up to 2° can be coupled with this unit, which can be operated at speeds to 5000 rpm with a max transmitted torque of 50 oz-in. **Commercial Products Dept., Reeves Instrument Corp., Roosevelt Field, Garden City, N. Y.**

Circle 15, inside back cover

Low-cost solenoid valves . . .

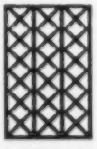
include as standard equipment molded-epoxy waterproof coils, unbreakable piston rings and guided pilot valve seats. Valves are packless, two-way, pilot-operated. For pressures to 400 psi and temperatures to 340 F. Line consists of gen-

(Continued on page 96)

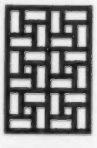


Top-Hat Quality IN Perforated Metal

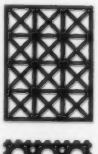
The popular Diamond Perforated-metal patterns shown above are only a few of the many illustrated and described in our 32-page Catalog No. 39. All of these standard patterns are available in a wide range of unit-opening sizes and we are always equally pleased to quote on original designs of any type or size.



Catalog 39 also illustrates and describes our high-quality lines of *Ornamental Cane*, Perforated-Metal Sheets for Accoustical installations and Heavy-Duty Architectural Grilles. Write, today, for a free copy.



Correspondence is especially invited regarding ANY requirement for perforated-metal panels or parts. We are equipped to fabricate special sections to any desired extent and welcome opportunities to make money-saving suggestions.



DIAMOND MFG. CO.
WYOMING WILKES-BARRE AREA PA.

Manufacturers of DIAMONTEX, the Perforated Metal Lay-In Panel for better Acoustical Ceilings. New Bulletin No. 47 gives complete illustrated information. Write for free copy.

Waldes Truarc GRIP RINGS Replace Expensive Parts... Reduce Manufacturing Costs...Eliminate Rejects

WALDES TRUARC SERIES 5555 GRIP RING*

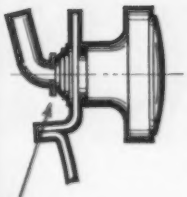
application: external for shafts

range: .077 in. — .755

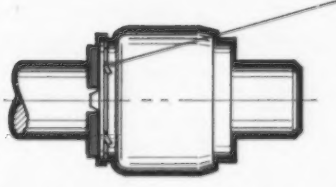
The Waldes Truarc Grip Ring requires no groove, holds fast by friction forces, can be used again and again. It provides a positioning shoulder secure against moderate thrusts or vibration. The ring's unusually large radial width exerts considerable frictional hold against axial displacement.

*U. S. Pat. No. 2,574,034

Rings cut costs 33%, eliminate rejects

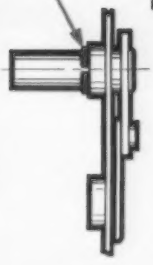


B & J Tool uses series 5555 grip ring to secure parts of damper control made for Vulcan Radiator. Shaft formerly was machined down to provide coil spring shoulder, often broke during bending operation. (Rejects ran as high as 80%!) New design eliminated rejects and field failures, cut production costs 33%.



Rings save $300 per die, $.03 unit

Ray Oil Burner Co. uses a Truarc series 5555 grip ring in fuel pump drive shaft to position seal and drive it to assure continuous rotation with shaft. Original design used complicated die-cast collar and driver which required special groove and shoulder. Savings: $300 per die for each size manufactured, $.03 per part.



Rings save $32.42/M:

Swift Business Machine Co. replaced collars and set screws in hollow shaft assembly of its adding machine with series 5555 grip rings, saving $32.42 per 1000 units. Rings require no groove, make possible positioning adjustments without slippage encountered when set screws were used.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C.1, N.Y.

Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.

(Please print)

Name_____

Title_____

Company_____

Business Address_____

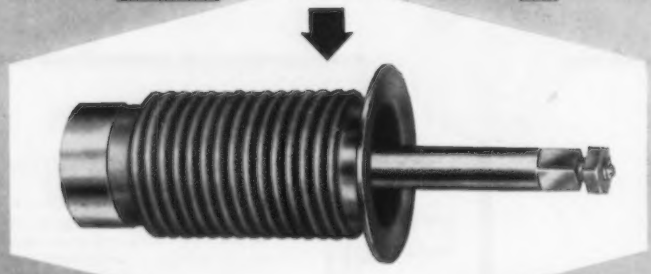
City_____ Zone____ State_____

PN9H

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor.

SAVE 6 WAYS

. . . buy complete bellows assemblies from one source!



Why buy bellows members and accessories from several sources . . . and assemble them at still another point? Fulton Sylphon can save you time, trouble and money by *custom* designing, producing and assembling complete bellows assemblies to your specific and exact requirements.

Specialized assembly skill and equipment carefully integrate the bellows and all needed accessories—heads, flanges, brackets, auxiliary bellows, tubing, thermostatic systems and housings. Large selection of bellows sizes, types and metals. The complete assembly is delivered ready to use . . . with these advantages:

1 One source delivery . . . and on time!	2 Entire assembly is pilot tested!	3 Only one incoming inspection!
4 Less handling and paper work!	5 Single source responsibility!	6 Integrated engineering!

Write for Bellows Catalog No. GP-1400

Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION · Knoxville 1, Tenn.

eral service valves in nine sizes from ⅜ in. to 3 in. Prices start at $13.25. Available for immediate delivery in any quantity. **J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18.**

Circle 16, inside back cover

DC power supplies . . .

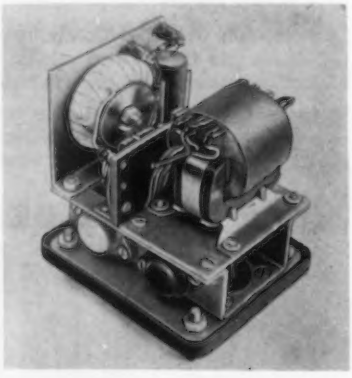
use transformer type, ventilated housings for max air circulation and accessibility to components. Unit may be used for either 230 or 115 v service, with proper input connections. Terminal is provided for adding external filtering for those applications requiring ripple less than 10 milliv without loss of regulation. Output is undergrounded and isolated. Available in 105 to 450-v models for use in control systems, guided-missile circuits and all types of miniature and standard electronic devices. **Datascan, Inc., 48 Notch Rd., Little Falls, N. J.**

Circle 17, inside back cover

Interchangeable couplings . . .

designed for quick connect and release, are available in male, female, hose-stem and reusable-hose-end connections in ¼, ⅜, ½ and ¾-in. sizes, with working pressures to 10,000 psi. Coupling locks automatically, without turning or twisting. Locking mechanism makes a positive, leakproof connection, said to be resistant to impact or rough handling. Full 360° swivel action eliminates hose kinking. Permits replacement of either coupling sockets or plugs without changing or having separate air lines to existing equipment. **Perfecting Service Co., Charlotte 6, N. C.**

Circle 18, inside back cover



Dc-to-ac static inverters . . .

are transistor-equipped for battery operation of motors, synchros, gyros, tape recorders and all equipment requiring ac power. Units are as light as ½ oz per va,

(Continued on page 100)

III

This is the third of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

What Does Grain Size Mean In An Alloy Steel?

The grain size of alloy steels is understood to mean austenitic or inherent grain size. Austenitic grain size should be distinguished from ferritic grain size, which is the size of the grains in the as-rolled or as-forged condition with the exception of those steels that are austenitic at room temperature. When steel is heated through the critical range (approximately 1350 to 1600 deg F for most steels, depending on the composition), transformation to austenite takes place. The austenite grains are extremely small when first formed, but grow in size as the temperature above the critical range is increased, and, to a limited extent, as the time is increased. It is apparent, therefore, that both time and temperature must be constant in order to obtain reproducible results.

When temperatures are raised materially above the critical range, different steels show wide variations in grain size, depending on the chemical composition and the deoxidation practice used in making the heat. Heats are customarily deoxidized with aluminum, ferrosilicon, or a combination of deoxidizing elements. Steels using aluminum or certain other deoxidizers in carefully controlled amounts maintain a slow rate of grain growth at 1700 deg F, while heats finished with still other deoxidizers, usually ferrosilicon, develop relatively large austenitic grain size at temperatures somewhat below 1700 deg F.

The McQuaid-Ehn test is the one ordinarily used for determining grain size. Steel is rated with a set of eight ASTM charts that are compared one at a time with a specially prepared steel sample until one is found to match. Number 1 grain size, the coarsest, shows 1½ grains per sq in. of steel area examined at 100 diameters magnification. The finest chart is Number 8, which shows 96 or more grains per sq in. at the same magnification.

PROPERTIES AFFECTED BY GRAIN SIZE

Fine-grain steels (grain sizes 5, 6, 7, and 8) do not harden as deeply as coarse-grain steels, and they have less tendency to crack during heat-treatment. Fine-grain steels exhibit greater toughness and shock-resistance—properties that make them suitable for applications involving moving loads and high impact. Practically all alloy steels are produced with fine-grain structures.

Coarse-grain steels exhibit definite machining superiority. For this reason a few parts which are intricately machined are made to coarse-grain practice.

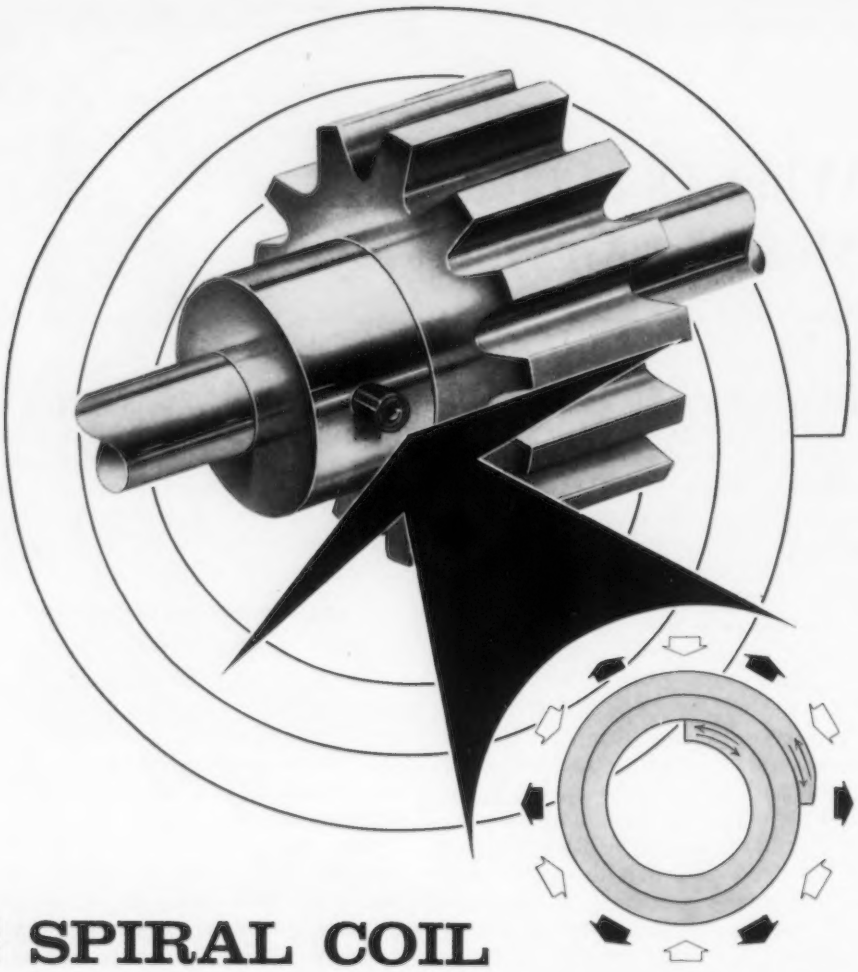
The correct specification and determination of grain structure in steel is a subject that has been given long study by Bethlehem metallurgists. If you would like suggestions on this or any other problem concerning alloy steels, these men will be glad to give you all possible help.

In addition to the entire range of AISI alloy steels, Bethlehem produces special-analysis steels and the full range of carbon grades.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL



THE SPIRAL COIL

makes SPIROL a true spring PIN

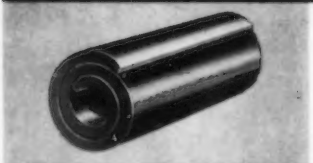
SPIROL PIN is a spirally coiled metal strip that acts like a true spring. When the pin is compressed into a hole, the radial tension is distributed *uniformly* throughout the spiral coils. There is no concentration of stress along a fragile "hinge line". This real coil-spring action permits wider plus-*and*-minus hole tolerances . . . eliminates precision reaming . . . works successfully with *low-cost* non-heat-treated metals. SPIROL's greater resilience increases shear strength, shock and vibration resistance.

FREE! *Write for literature on Spirol Pins.*

SPIROL *the true spring* **PIN**

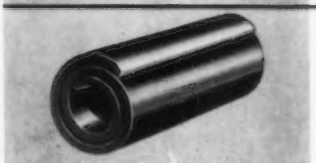
C. E. M. COMPANY • 104 SCHOOL ST. • DANIELSON, CONN.

SPIROL offers the widest range of flexibility, tension, and strength . . .



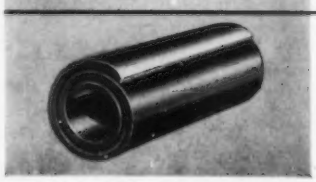
HEAVY DUTY

For applications where shear and shock loads are extremely severe, Spirol pin's spring action withstands high stress.



MEDIUM DUTY

Flexibility enables medium duty pins to absorb severe vibration. Have adequate shear strength for majority of applications.



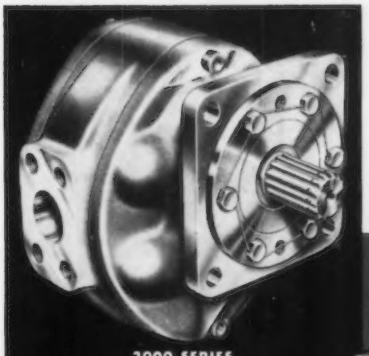
LIGHT DUTY

Recommended for use in soft and brittle materials where the allowable bearing loads are low.

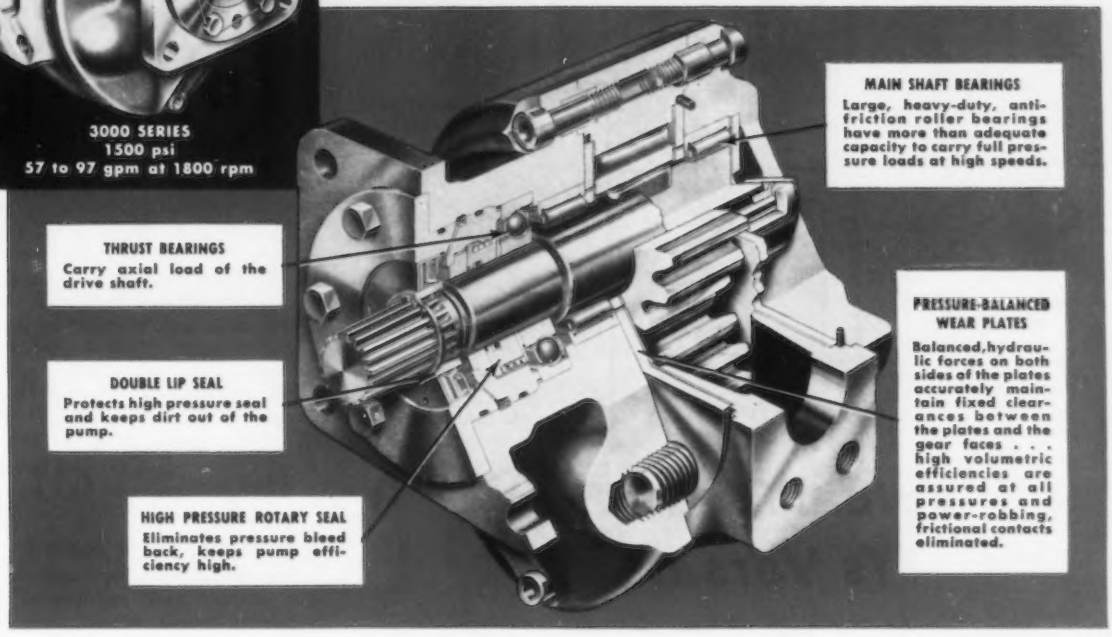
NOW • Added Service Life for the Accepted Leader Among Heavy Duty Fluid Power Pumps

HYDRECO

Series 3000
FLUID POWER PUMPS



3000 SERIES
1500 psi
57 to 97 gpm at 1800 rpm



MAIN SHAFT BEARINGS
Large, heavy-duty, anti-friction roller bearings have more than adequate capacity to carry full pressure loads at high speeds.

THRUST BEARINGS
Carry axial load of the drive shaft.

DOUBLE LIP SEAL
Protects high pressure seal and keeps dirt out of the pump.

HIGH PRESSURE ROTARY SEAL
Eliminates pressure bleed back, keeps pump efficiency high.

PRESSURE-BALANCED WEAR PLATES
Balanced, hydraulic forces on both sides of the plates accurately maintain fixed clearances between the plates and the gear faces . . . high volumetric efficiencies are assured at all pressures and power-robbing, frictional contacts eliminated.

APPLICATIONS

EARTH MOVING EQUIPMENT
CONSTRUCTION MACHINERY
MATERIALS HANDLING EQUIPMENT
AGRICULTURAL MACHINERY
MOBILE and GENERAL
INDUSTRIAL EQUIPMENT

Member NFPA

The basic design of HYDRECO Fluid Power Pumps has been proven in thousands of successful installations . . . on Earth Moving, Materials Handling and Agricultural equipment . . . where dependability, efficiency and ruggedness are of prime consideration. *Now*, this famous design has been refined by improvements that give you this outstanding performance PLUS — *substantially extended service life — three times greater!* Translated in terms of dollars and cents, this greater service life adds value to the Pumps you buy and pays your customers extra dividends on their investment.

Check the features shown above... combined, they enable HYDRECO Series 3000 Pumps to set new standards in performance, efficiency and trouble-free service.

Write—

for performance and installation data on HYDRECO 3000 Series Fluid Power Pumps.

Kalamazoo Division
The New York Air Brake Company
9012-4 East Michigan
Kalamazoo, Mich.

Please send me complete information on HYDRECO Series 3000 Pumps.

Name_____
Company_____
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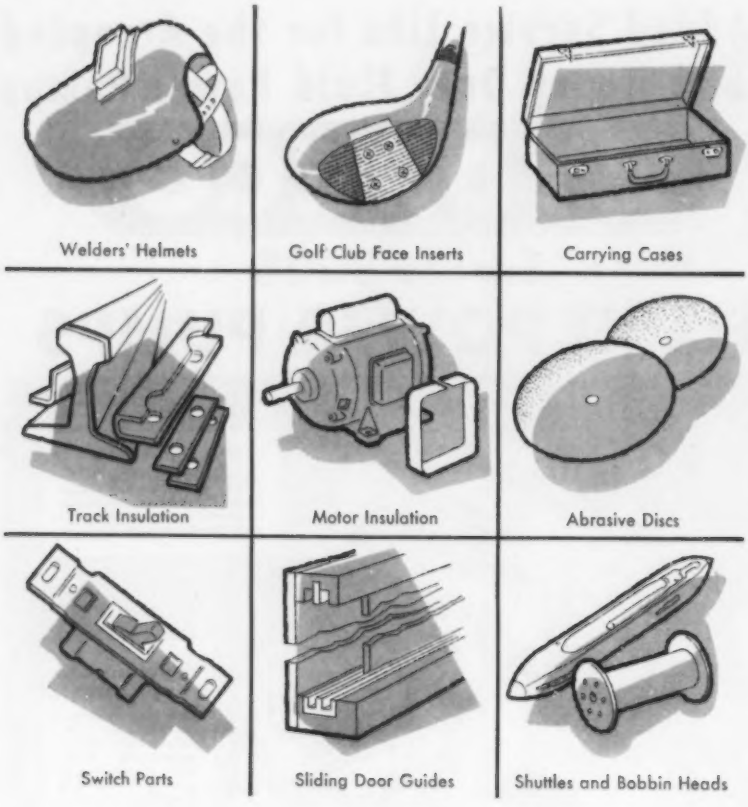
City_____ Zone____ State_____

THE NEW YORK AIR BRAKE COMPANY
KALAMAZOO DIVISION • KALAMAZOO, MICHIGAN

A few typical applications of Taylor Vulcanized Fibre



Vulcanized Fibre Is Versatile

The applications of Taylor Vulcanized Fibre are many in number. This is because of its many unusual characteristics. It is a hard, dense material with excellent physical, mechanical and electrical properties. It is tough and resilient; has high resistance to impact, abrasion, wear, organic solvents, oils and gasoline; it can be machined, stamped, punched and formed; it is attractive in appearance, light in weight.

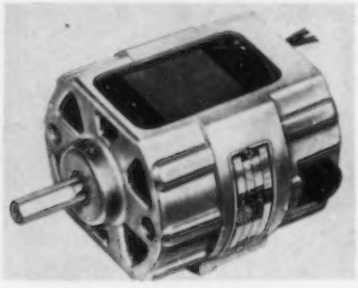
Taylor Vulcanized Fibre is available in a number of different grades, in sheets, rolls and turned rods. Undoubtedly you have an application where the unique properties of vulcanized fibre can be put to work in your product. A Taylor application engineer will be glad to discuss requirements with you and recommend the best grade to fit them. Get the benefit of his advice by contacting TAYLOR FIBRE CO., Norristown 39, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

as small as $\frac{3}{4}$ cu in. per va and have efficiency to 98%. Operate from either 6 or 12 or 28 or 64 v dc. Available in sinusoidal or square-wave outputs, in single or three-phase models in a wide variety of frequencies. **Universal Transistor Products Corp., 17 Brooklyn Ave., Westbury, N. Y.**

Circle 19, inside back cover



Intermittent-duty motor . . .

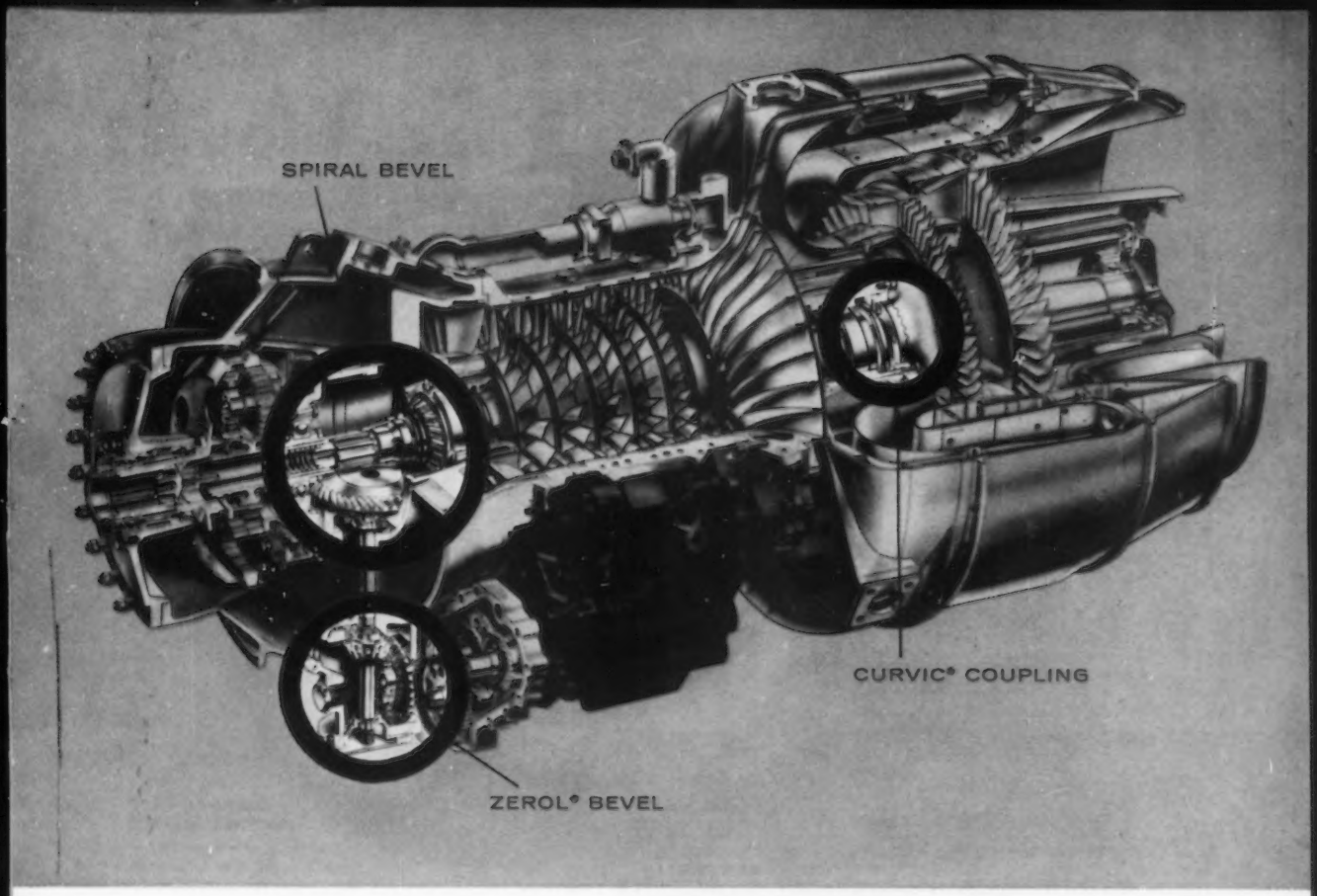
of $\frac{1}{4}$ hp is series wound, self-ventilated, and has a nominal speed of 5000 rpm. It runs in a single direction, clockwise or counterclockwise, is rectangular-shaped, $2\frac{7}{16}$ in. high, and has a natural die-cast aluminum finish. Designed for use in adding machines, calculators, check protectors and signers and actuators. **Bodine Electric Co., 2254 W. Ohio St., Chicago 12.**

Circle 20, inside back cover

Self-contained mist coolant . . .

includes an air filter, trap, regulator and gage, solenoid valve and conduit box, pressurized coolant reservoir and filter. Pressurized coolant reservoir permits mounting in any location without siphon-lift problems, interrupted flow or air waste. Coolant and air are separately fed under pressure to the tip, where they are atomized to produce a cooling mist. Stub, rigid-extension and flexible jets are available for cutting, sawing, grinding,

(Continued on page 104)



How to get *engineering assistance* on gears and couplings like these

Gleason engineers are always ready to help you work out any problems involving bevel gears and couplings.

Such assistance came to the makers of this turbine in four different areas:

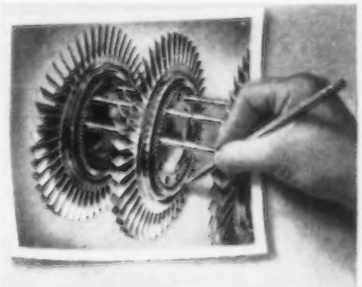
First, they naturally wanted components which met the designated theoretical requirements of the turbine. Our engineers helped determine the types and sizes of the gears and Curvic® coupling as well as such details as axial thrust and radial load.

Second, they wanted compactness. The angular drives made possible by the spiral bevel and Zerol® bevel systems helped materially to fit the drive into the limitations set by the turbine's over-all dimensions.

Third, they wanted low costs. The machines and methods developed by Gleason engineers assure the lowest possible costs for both gears and couplings whether made in small or large quantities. The Curvic coupling design inherently cuts coupling costs; see picture at right.

Fourth, the makers wanted extreme reliability. The success of the gears and couplings in this respect is witnessed by the fact that this turbine is used by six major aircraft companies and has recorded more hours of flying time than any other turbine in its power class.

If you would like to discuss your bevel gear or coupling application with a Gleason representative, please contact us.



With Curvic couplings complex machine parts can be made in several small units, reducing machining time, simplifying final assembly, and cutting over-all manufacturing costs.

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

bright idea

For enduring beauty that sells in a new car and re-sells in a used car . . . design it, improve it and protect it with McLOUTH STAINLESS STEEL.

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HIGH QUALITY SHEET AND STRIP

for automobiles

McLOUTH STEEL CORPORATION DETROIT, MICHIGAN

MANUFACTURERS OF STAINLESS AND CARBON STEELS

Avoid costly down-time caused by electrical control failure....

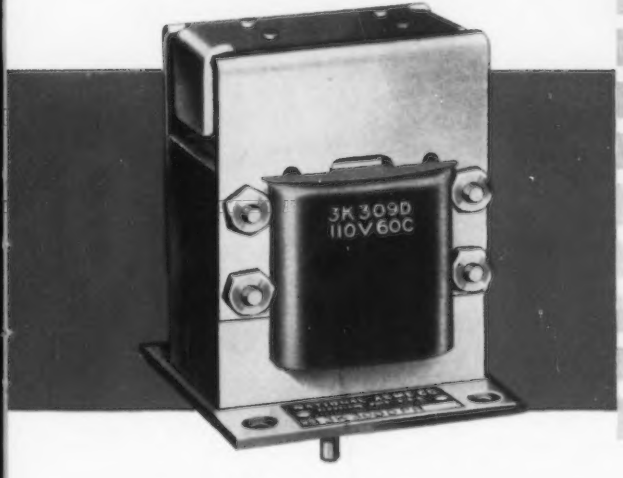
Nothing is more frustrating to the production man than downtime caused by the failure of a minor component. An $85,000 machine tool down because of a failure of a limit switch can be as expensive as if it were caused by a main bearing burnout. National Acme's electrical controls are designed by machine tool designers and built as machine tools are built. That means extra ruggedness, extra dependability but it does not mean extra cost.

GOLD-N-RING CONTROL SWITCHES

Oil-tight, water-tight, dust-tight. Built with heavy duty silver alloy contact points, over-size terminal screws, superior dielectric materials. For full information ask for a free copy of Bulletin ECS-56.

LIMIT SWITCHES

A full line of heavy duty Limit Switches designed originally for machine tool installation but now used wherever extra dependability, extra ruggedness and long life are required. For full information ask for a free copy of our Bulletin EM-51.



NAMCO SOLENOIDS

A full line of standard and custom made Solenoids for AC or DC use. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A provides information on the application, design and installation of Solenoids. Write for your free copy today.

Electrical Manufacturing Division

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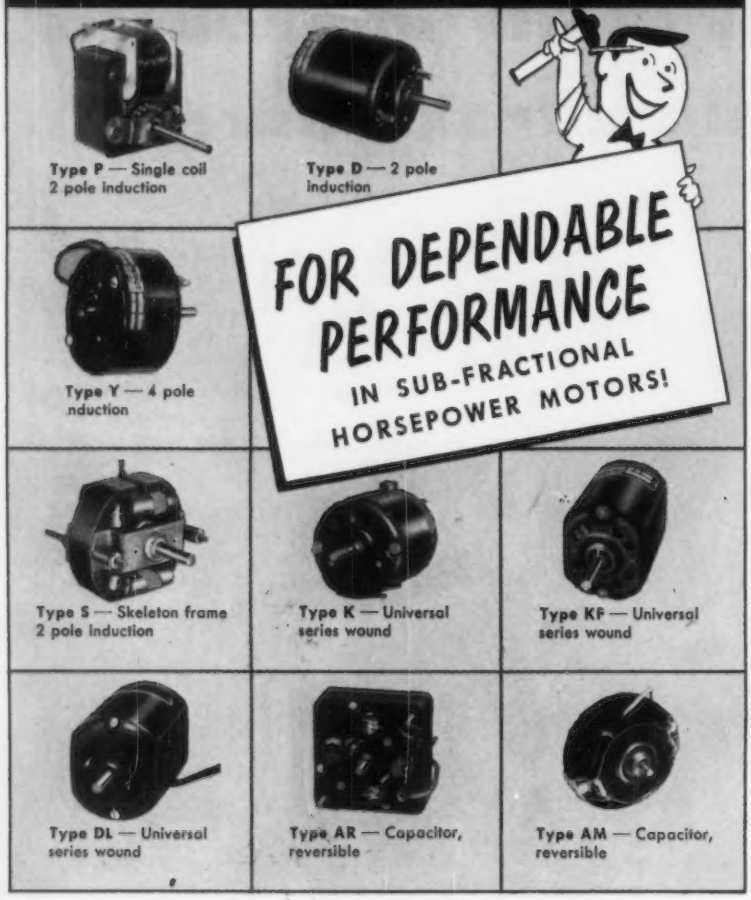
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FOR DEPENDABLE PERFORMANCE
IN SUB-FRACTIONAL HORSEPOWER MOTORS!
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Type AR — Capacitor, reversible
Type AM — Capacitor, reversible

Heinze Sub-Fractional Horsepower Motors offer you a comprehensive line — personal engineering service — dependable quality. You have a wide selection of types, mountings, horsepower, voltage ratings and other modifications. When adaptations are needed, Heinze Engineers give prompt, personal service to meet your exact requirements. There's no unwieldly red tape — no lengthy delays in design or production. You get high quality motors that are rugged, compact, lightweight, low in cost. So when you need sub-fractional horsepower motors, be sure to *put Heinze in your designs.*

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685 Lawrence St., Lowell, Mass.
Sub-Fractional Horsepower Motors and Blowers

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milling, turning, boring or tapping operations. The unit also features multiple-jet operation, made possible by branching from existing lines. Available in 1-gal or 18-oz-capacity reservoirs. **Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.**

Circle 21, inside back cover

25 and 50 hp diesels . . .

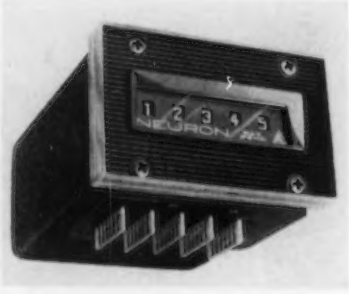
require less space to install than a gasoline engine of equal horsepower. Incorporate replaceable wet-type liners, main bearings between each throw and at both ends of the crankshaft, full-pressure lubrication, oil-bath air cleaner, oil-cooled pistons and a 22:1 compression ratio. Both models can be adapted for replacement power, standard, or optional original equipment without problems of installation or engineering imposed by space or weight limitations. **Sheppard Diesels, Hanover, Penna.**

Circle 22, inside back cover

Multi-design expanded metals . . .

now include patterns with two or more characters or design elements in the same sheet. Openings vary from $\frac{1}{16}$ to $1\frac{1}{2}$ in. and from 0.015 to 12 gage. Also, light-gage meshes are now manufactured in coil form so that raw material can be processed through slitter lines and automatic shears for mass-production application. **Designers Metal Corp., 567 E. 159th St., Harvey, Ill.**

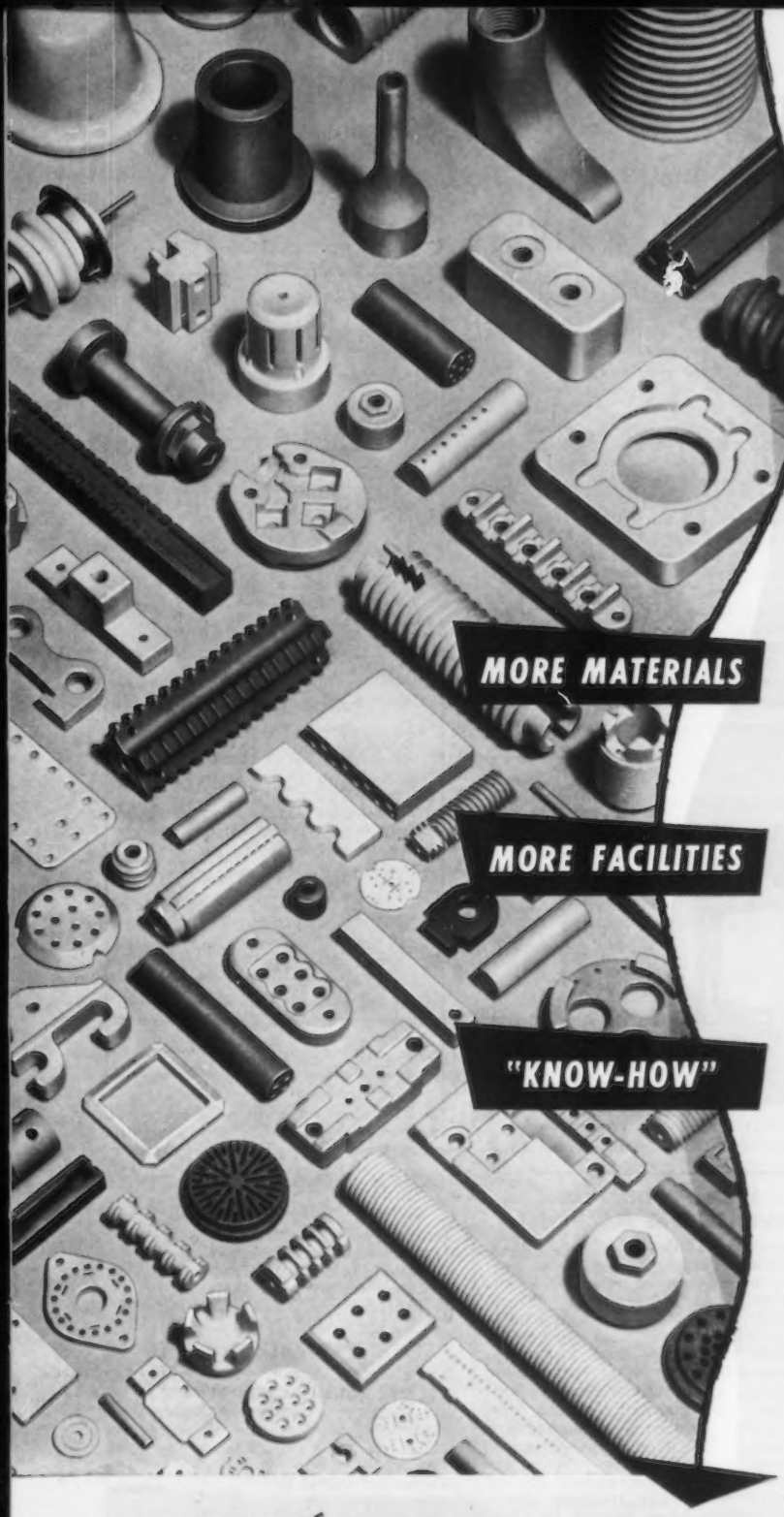
Circle 23, inside back cover



High-speed readout counter . . .

features rates to 40 counts per sec and is available with manual or electrical instantaneous pulse reset. Life is said to be 300 million counts. Offers switch readout function on each point of its five digital wheels. Also available are models responding to a variety of ac and dc actuation voltages. Intended for high-vibration and heavy g-load applications, counter has a bidirectional stepping mechanism that cannot double-index during shock, vibration

(Continued on page 108)



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Modern machinery in depth for volume production by the most efficient methods. Great latitude in shapes and sizes. Special equipment for holding precision tolerances. The latest inspection instruments. Kilns of many kinds. Hand-machined prototypes for testing your designs before tooling if desired.

AlSiMag production is a science . . . but also an art. Technical knowledge and skilled craftsmen are equally important. Here exclusive techniques have been developed over more than half a century of specialized experience. Our engineers can often offer redesign suggestions to improve performance and reduce costs.

Designs carefully studied before orders accepted . . . but in almost 100% of the cases which are accepted, AlSiMag parts are produced to specification on promised schedule. Blueprint or sketch with details of operation will bring you complete information on AlSiMag for your application.

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Fastener Facts

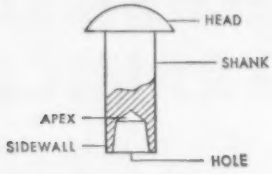
DESIGN PRODUCTION & PURCHASING DATA

by Paul Tunison, Chief Engineer — Judson L. Thomson Mfg. Co.

FASTENING WITH SEMI-TUBULAR RIVETS

WHY RIVETS?

You specify rivets when you want strong, permanent fastening at low cost. However, secure fastening is not their only function. You can also use them as fulcrums, pivots, cam followers, electrical contacts, studs, stops and in many other applications.



Typical semi-tubular rivet

WHY SEMI-TUBULAR RIVETS?

You specify semi-tubular rivets when you want to combine the high shear and compression strength of solid rivets with low-cost, high-speed fastening. The required strength is inherent in the design of Thomson Semi-Tubular Rivets.

Shallow holes in solid shanks distinguish semi-tubular rivets from other types. The hole is seldom deeper than shank diameter. Its depth is determined by clinch requirements of specific applications. A general rule is to select a rivet with length equal to the thickness of the materials *plus* 55% of the diameter of the shank. A Thomson engineer can quickly specify the correct rivet length and hole depth for any particular semi-tubular riveting application.

Semi-tubular rivet applications call for pre-drilled or punched holes in the materials to be fastened: metals, plastics, wood, ceramics and other hard materials. The size of the prepared holes is an important design consideration. When holes are too small, rivets choke. When too large, rivets buckle. To avoid either error, make sure that each hole is about 7% larger than the maximum shank diameter of the rivet. In most cases, the setting process causes shank expansion sufficient to fill the hole. Again, Thomson engineering is at your service to help you match rivet and hole sizes.

High shear strength of semi-tubular rivets is further assured by Thomson production methods. All Thomson Semi-Tubular Rivets are made from specially prepared wire by the cold heading or upsetting process. This results in fasteners with the uniform structure and *inherent strength of forgings* . . . properties not achieved by screw-machine rivet production.

Standard materials used to produce Thomson Semi-Tubular Rivets include aluminum, brass, copper, nickel-silver, low-carbon steel and stainless steel. For special electrical and electronic contacts, coin silver, fine silver, palladium and other precious metals may be specified.

Finishing to specifications is another service of interest to design engineers. Rivets can be plated with brass, cadmium, copper, nickel, tin, zinc, etc. Morever, they can be oxidized or finished in japanned colors to match the original equipment or product.

Low fastening costs result from the application of Thomson Semi-Tubular Rivets with automatic rivet-setting machines. The low cost of rivets, as compared with most other fasteners, combined with high machine speeds invariably leads to production line economies. Machines are low in initial cost and require little maintenance. Furthermore, they can be operated by unskilled labor.

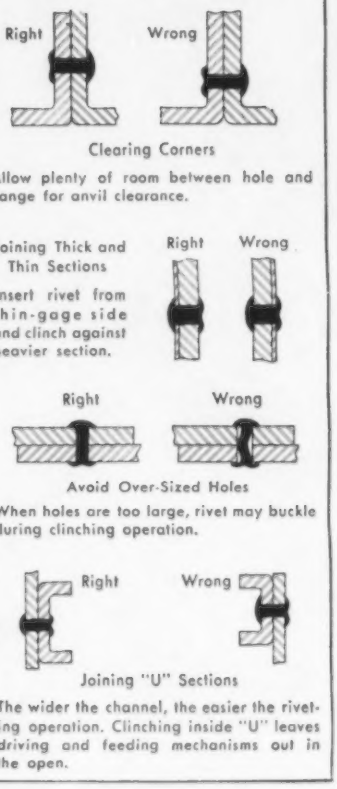
FLOOR-TYPE FOOT-OPERATED — FLOOR-TYPE MOTOR-OPERATED

HIGH PRODUCTION RIVET-SETTING MACHINES

Thomson has developed more than 200 styles of modern, high speed machines which can be adapted to innumerable fastening jobs. These machines are divided into three basic models: floor type with foot-pedal operation, floor type with motor operation, and bench type with motor operation. All permit automatic hopper feed for maximum speed, and some motor driven floor models are equipped for multiple rivet-setting.

Special work-handling devices accelerate riveting operations. Radial or turret feeds are common accessories for machines geared to high-production fastening of parts, as are all types of special loading fixtures. Thomson selects the proper machine to do your job most efficiently and custom-tools it to fit your fastening requirements.

DESIGN PRACTICES


Right
Wrong
Clearing Corners
Allow plenty of room between hole and flange for anvil clearance.
Joining Thick and Thin Sections
Right
Wrong
Insert rivet from thin-gage side and clinch against heavier section.
Right
Wrong
Avoid Over-Sized Holes
When holes are too large, rivet may buckle during clinching operation.
Right
Wrong
Joining "U" Sections
The wider the channel, the easier the riveting operation. Clinching inside "U" leaves driving and feeding mechanisms out in the open.

DESIGN & ENGINEERING SERVICE

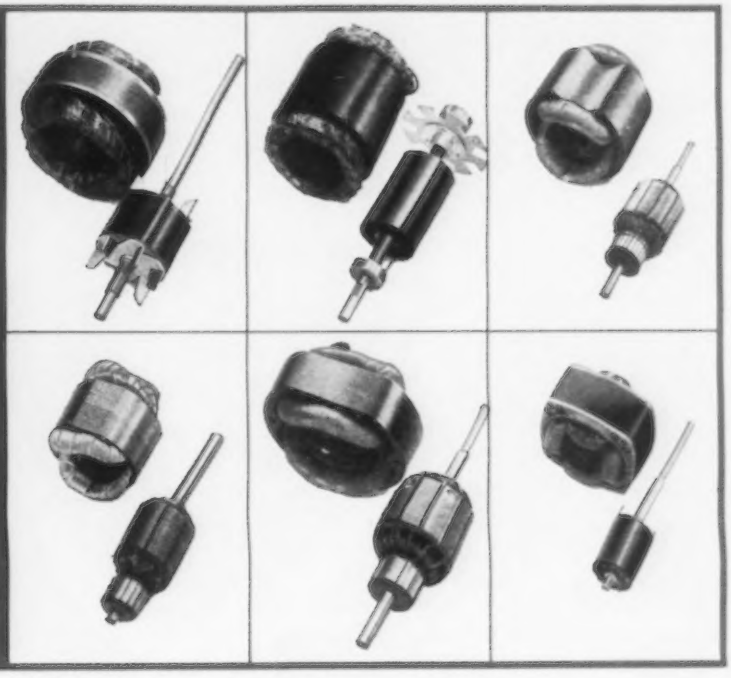
We will gladly evaluate your fastening problems at little or no cost. Contact us while designs can still be modified for lowest cost fastening method. Simply send sketches, prints, or preferably samples of actual work.

FREE "FASTENER FACT FILE"

Be one of the first to profit from our new manual on all phases of riveting. It covers rivet types, applications, materials, finishes, and other factors that determine selection of the right design, rivet and machine for cutting fastening costs. Request your copy today. Write Judson L. Thomson Mfg. Co., Dept. C, Waltham 54, Massachusetts.

JUDSON L. THOMSON MFG. CO., WALTHAM 54, MASS.

a complete line of HOWARD and New Howard (FORMERLY WESTINGHOUSE) motor parts sets in ratings from 1/200th to 1 h.p.



Illustrated here are a few of the motor parts sets in the complete Howard line. They are currently handling the power requirements of portable power tools, floor polishers juice squeezers and thousands of other widely varied applications. Designed to be built directly into the housings of products and appliances, Howard Motor Parts Sets include armatures and fields, brushes and brushholders, rotors, stators and fans—in any combination, as needed. Whatever your application, there is a standard Howard parts set or variation to match your specifications. If your requirements are in the range of ratings from 1/200th to 1 H.P., check with Howard today.

Now also exclusively available from Howard are the former Westinghouse Motor Parts Sets. Contact Howard for samples and specifications.

SPECIFICATIONS

ARMATURES

Parts Set No.	No. of Slots	Outside Diameter	Inside Diameter	Core Sizes Available
11A	11	1.375	¼ ⅜	¾, 15⁄16, 1, 1¼
150	12	1.379	⅜	¾, 1, 1¼, 1½
200	8	.960	¼	¾, ⅞, 15⁄16, 1
500	12	1.506	.359	¾, 1, 1¼, 1½
700	14	1.812	⅜ ½	1¼, 1½, 1¾, 2
900	13	1.600	⅜	1¼
2700	7	1.380	¼	1, 1¼, 1½

COMMUTATORS

No. of Bars	Insulation	Hubs
11 or 22	paper, mica, bakelite, or nylon	molded or steel
24	paper, mica, bakelite, or nylon	bakelite or steel
16	paper or mica	steel
24	paper or mica	steel
28	paper	steel
26	paper or mica	steel
7 or 14	paper or mica	steel or bakelite

ALL MODELS:

SHAFTS:
Shafts are ground from centers for concentricity. Special flats, worms, etc., can be cut on shafts if required. C.R. Steel is normally used, however stressproof or various types of stainless steels can be furnished if desired.

INSULATION:
Armatures have a fiber end insulator at both ends of the steel laminations. The inside of the slot is insulated with varnished cambric. The armature is wound with heavy formvar copper wire.

LAMINATIONS:
Laminations are stamped in sets from 24 or 26 gauge improved electrical sheet steel. They are riveted together under pressure in an expanding die. The outside diameter of the field can be ground to customer's specifications. Field coils are wound with heavy formvar copper wire, taped with cotton rayon tape, inserted in field core, then double dipped and baked in an insulating varnish. Field leads can be cut to desired length.

MISCELLANEOUS:
Brush holders and caps with correct brush assemblies can be supplied upon request. Special length cores can be made if required. Armatures can be either statically or dynamically balanced, or both, if required.

POWERED BY **HOWARD**

Other Howard motors: UNIVERSAL & D.C. 1/200 to 1 h.p. • SHADED POLE 1/2000 to 1/8 h.p. INDUCTION 1/1400 to 1/8 h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

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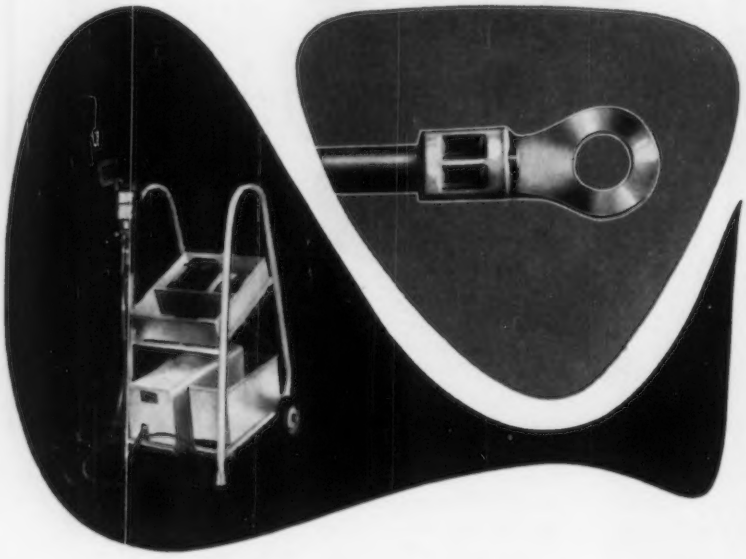
and DYNA-CRIMP® tools—



the right combination . . .

for electrical power generation and distribution

Take any assortment of conductors—solid, stranded or irregularly shaped. Add one A-MP Solistrand terminal. Bring them together in the proper A-MP Dyna-Crimp tool.

The result is always the same—an electrically-perfect, crimp-sure attachment at lower installed cost. Top performance even in adverse conditions.

And Solistrand needs no servicing. This is especially valuable where you have power machinery that must be left unmanned for long periods. Check these important Solistrand features:

- Exclusive double-indented crimp weds Solistrand barrel to conductors in a never-fail attachment.
- Crimping action of Dyna-Crimp tools forces combinations of conductors into one homogeneous mass. It does this at exactly the right pressure—no more, no less—for maximum conductivity and maximum strength with no weakening of conductors.
- Solistrand terminals are scientifically engineered in sizes to fit wires from No. 22 to 600 mcm.

And to serve you better, AMP maintains an international staff of field engineers capable of solving all your terminal problems.

Write for our Solistrand terminal and connector catalog.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

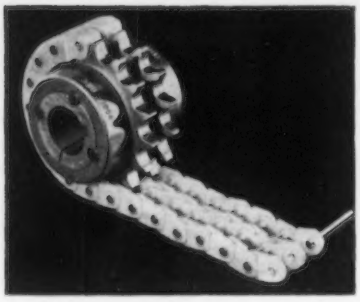
or over-voltage. Static-switch-current capacity is 1 amp; dynamic-switch-current capacity is 100 ma. Prices range from $178 for basic add-only manual reset counter to $300 for more complex units. **Autron Engineering, Inc., 1254 W. 6th St., Los Angeles 17.**

Circle 24, inside back cover

Welding of terminals . . .

and connectors to stranded electrical wire by a new welding method does not destroy wire insulation or indent or abrade wire. Wire strands are covered with a sheathing of base metal to prevent corrosion, flexing and crystallization, yet welding is visible. Copper strands and terminals are produced from coiled strip by an automatic machine that crimps, welds and cuts off. **Electric Terminal Corp., 3 Bellows St., Providence 5, R. I.**

Circle 25, inside back cover



Flexible nylon coupling . . .

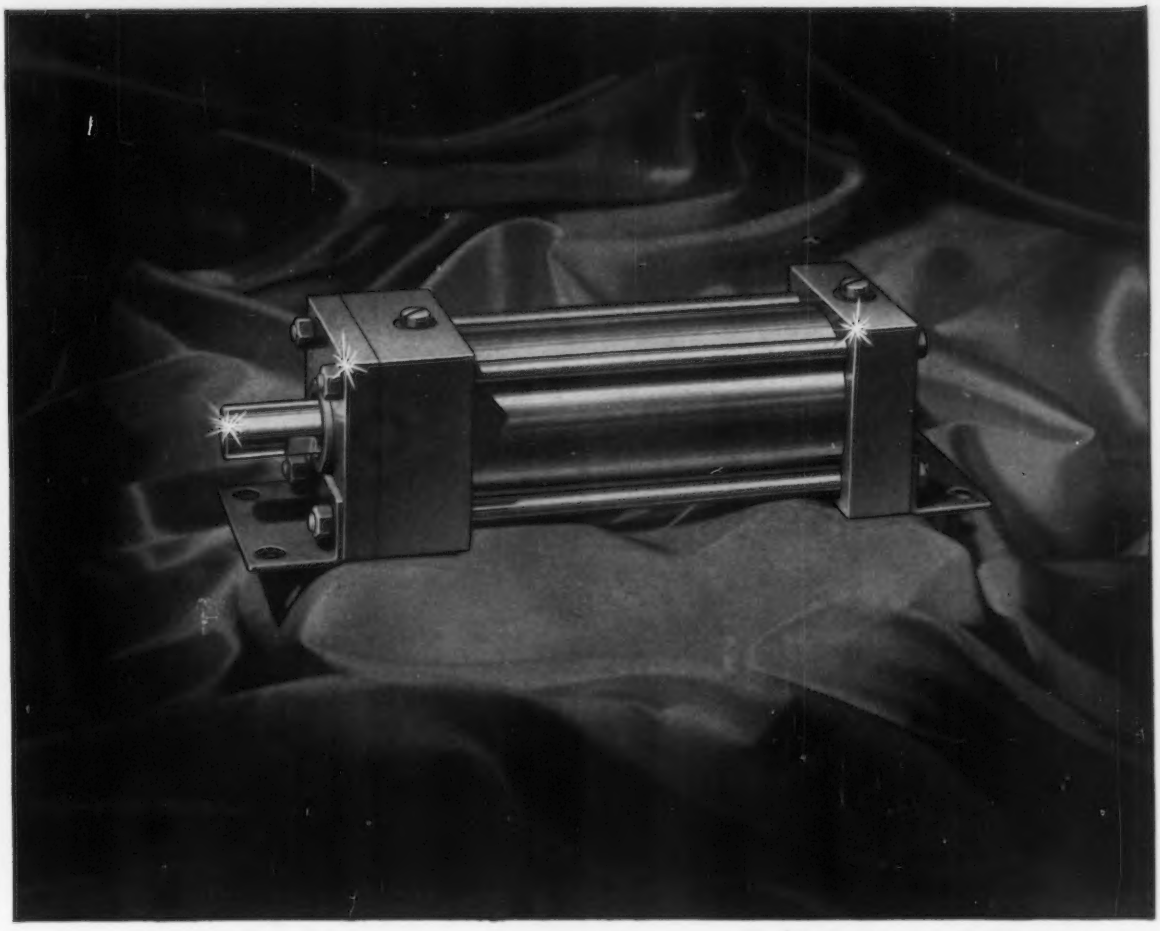
can be disassembled or connected at any link without special tools and fits standard, steel roller-chain sprockets. Constructed of nylon segments and stainless steel pins. Coupling needs no protective cover, handles loads from fractional to 40 hp and speeds from 500 to 5000 rpm. Complete couplings, ½-in. pitch links and soft steel sprocket, or chain elements are said to cost about 20% less than all-steel counterparts. **Morse Chain Co., Ithaca, N. Y.**

Circle 26, inside back cover

Air-gap limit switch . . .

operates without physical contact and is designed for applications where heavy impact and shock cause mechanical limit switches to break down. Consists of a magnetic vane, which is attached to moving portion of machine, a reactor unit, mounted on stationary portion of machine, and a standard ac relay. High sensitivity permits switch to function when vane is within ⅞ in. of reactor. Operation is not affected by voltage variations to 10%. Operates in same temperatures as a me-

(Continued on page 112)



Illustrated—Logansquare Cylinder Meets J.I.C. Standards

Look to Logan

the ultimate in air cylinder design

FREE SEND FOR THE "LOGAN CALCULATOR"
A gift to you from Logansport Machine Company upon request.

MEMBER: Natl. Mach. Tool Builders' Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
812 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
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- ☐ 100-6 ULTRAMATION CYLINDERS
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- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 AND 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 300-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

TO:

NAME _____ TITLE _____

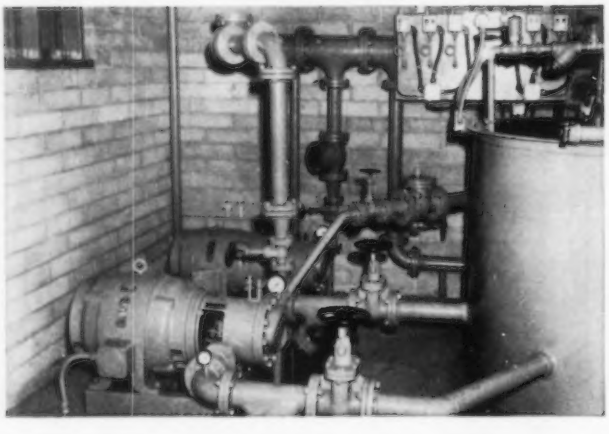
COMPANY _____

ADDRESS _____

A hippo surfaces with a cavernous yawn—powered by water from F-M pumps shown below.

From butterflies to hippopotami

F-M pumps make animals "live"



In one of the world's most fabulous amusement parks, waterfalls tumble; rivers flow; hippos yawn, and giant butterflies flap their wings—all water-powered by Fairbanks-Morse pumps with F-M motors.

Although a most unusual application, these F-M installations demonstrate the flexibility and experience of Fairbanks-Morse in working with the engineers of any organization.

Whatever type, size or capacity pumps you need—you're sure of satisfaction when you call in your F-M Sales Engineer. Contact him today, or write directly to Fairbanks, Morse & Co., 600 South Michigan Avenue, Chicago 5, Illinois, Dept. PE-4-14.

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a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

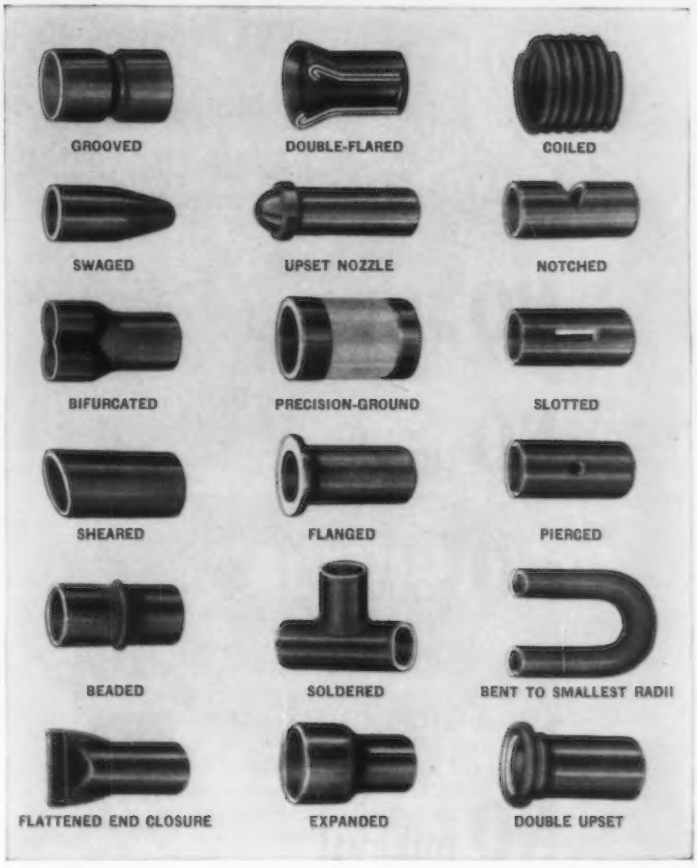
Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN



Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, ITALY, AND GERMANY

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

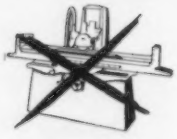
DOUBLE-WALLED FROM A SINGLE STRIP

NO, NO... a thousand times "NO"

"NO loss of time," say the thousands of users of LAMINUM SHIMS...

NO machining!

NO grinding!



NO counting!

NO stacking!

NO miking!

LAMINATED SHIMS OF

LAMINUM®

SURFACE BONDED... THEY *peel* FOR ADJUSTMENT

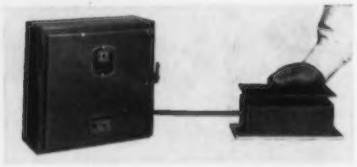
Laminated Shims of LAMINUM now available in

STAINLESS STEEL with laminations of .002" or .003"	ALUMINUM with laminations of .003" only
BRASS with laminations of .002" or .003"	LOW CARBON STEEL with laminations of .002" or .003"

LAMINATED SHIM COMPANY, INC.

Shim Headquarters since 1913

1404 Union Street, Glenbrook, Conn.



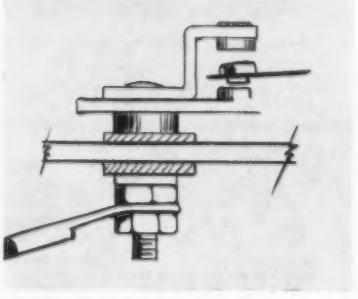
chanical limit switch. **Electric Controller & Mfg. Co., Div. of Square D, 4500 Lee Rd., Cleveland 28.**

Circle 27, inside back cover

Recoil tubing . . .

is fabricated from neoprene-base material. Horizontal lead screws, acme threads, worm screws and slow-cycling piston rods are protected by the pliable coil without use of external guy-rods or grommet supports. Coolant spray, chips, grit, dust and other abrasives are excluded while the lubricant is retained. All types of end-fastening collars and flanges can be accommodated. **A & A Mfg. Co., Inc., 712 S. 12th St., Milwaukee 4.**

Circle 28, inside back cover



Mounting is terminal . . .

for snap-action switch. It permits installation on one side of panel and wiring from the other. A rubber grommet on both sides provides panel insulation. Machined stud terminal is riveted to contact brackets for rigid installation and positive

(Continued on page 116)

NEW ACTIONATOR*

Heavy Duty Electric Motor
Operates Valves, Dampers, Louvers

This compact, rugged new industrial motor gives dependable, low-cost service. Use the *ACTIONATOR* to operate valves, dampers, louvers and other final control elements. It's available with on-off, two-position, floating or proportional control.

Features include:

- **High torque ratings**—to 200 inch-pounds.
- **Fast speeds**—available to meet application requirements.
- **Internal brake**—to hold load in any position without coasting or hunting.
- **Great sensitivity**—the proportional control model can take full advantage of the most sensitive proportioning relays.
- **Easy adjustments**—readily accessible, field adjustable, cam-operated travel and auxiliary switches.
- **Squared end shafts**—for positive, non-slip attachment of crank arm.

For complete details on the new *ACTIONATOR* industrial motor, write for Specification S804-3, or call your nearby Honeywell field engineer.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

**Minneapolis-Honeywell tradename*

Honeywell

First in Controls

NEW INDUSTRIAL VALVE MOTOR

Series 831E has extra power for highly accurate control

This powerful new Industrial Valve Motor is designed primarily for valve and damper applications. It is suitable for many other control applications where high accuracy and reproducibility are required. Some of its outstanding features:

- Positive control action without coasting.
- Accurate positioning of final control elements over full drive shaft rotation.
- Arc-suppression circuit to protect auxiliary relays.
- Variety of speeds (3 to 120 seconds) and modes of control available.
- Rated output torque—up to 62.5 ft. lbs.

For details, write for Specification S804-2, or call your nearby Honeywell field engineer.

University

produces a powerful but very compact soundcaster by using

DIE CASTING

CASE HISTORIES FROM MT. VERNON FILES

In this model PP-2 Pistolgrip "Powrpage," University has embodied the most advanced features of any electric sound-casting system. Aim, press, talk —it projects clear, powerful sound in any direction. A mighty voice for such a compact, light weight unit, only 4½ pounds including batteries. The Pistolgrip with microphone built into the horn base permits ready, one hand use. 6 pencil batteries are all held in the slim handle which also contains the "Powrsaver" press-to-talk switches and—the entire unit is *weatherproof* throughout.

How was such compact design achieved . . . by resorting to die casting which gives thin, rigid sections of great strength.

How was weight brought down to 4½ pounds . . . by die casting three main parts in aluminum.

How was cost held down to lowest figures possible . . . by utilizing all the inherent advantages of die casting to make the intricate shapes economically. The two-casting handle houses microphone, driver unit and power supply and the tone arm combines an outer shell with four spacer arms and an inner sound director core into one unit.

How was it made so weatherproof . . . because die castings can be held to extremely tight tolerances.

You too can realize the many advantages of die casting by using the complete service available from Mt. Vernon's coordinated designing, die-making, casting and machining facilities all under one roof, which can supply die cast zinc and aluminum parts ready for use. Contact your nearest Mt. Vernon sales representative for action.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

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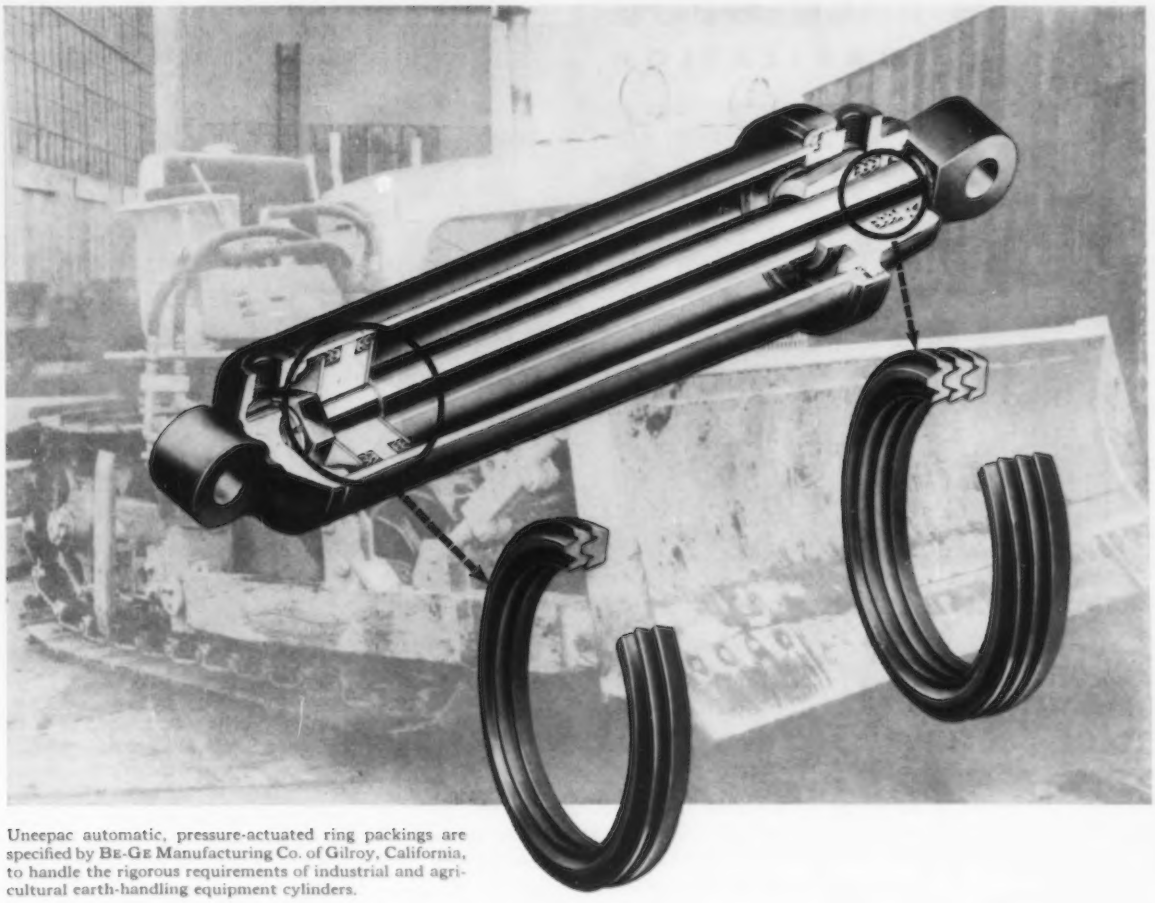
Rigorous tests convinced BE-GE to use J-M Uneepac® in their rugged cylinders



Uneepac automatic, pressure-actuated ring packings are specified by BE-GE Manufacturing Co. of Gilroy, California, to handle the rigorous requirements of industrial and agricultural earth-handling equipment cylinders.

Uneepac proves it can handle shock pressures to 4,000 psi in three-year, life-test program

• BE-GE Manufacturing Company's line of cylinders for their hydraulic systems has to stand up to years of day-in, day-out abuse. That's why BE-GE engineers subjected J-M Uneepac Rod Packings to a 350,000-cycle test and Uneepac Piston Packings to a 150,000-cycle test in a three-year program that proved Uneepac can take working pressures to 2,500 psi—shock pressures to 4,000 psi. As proof of performance, Uneepac is now the specification packing on all BE-GE standard—and heavy-duty cylinders.

Pressure-actuated Uneepac Rings offer high-efficiency sealing in minimum packing depth. Each ring provides an efficient, individual seal—nests with adjacent rings in an interlocking manner without compression adjustment for true, multiple-ring action.

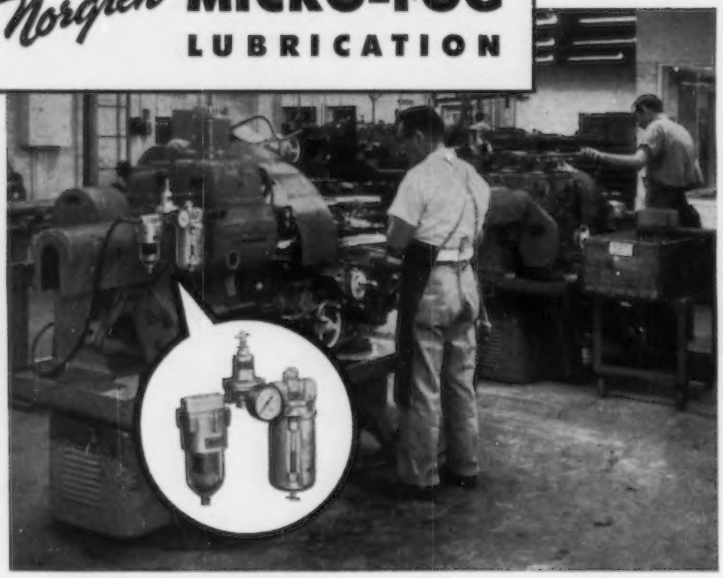
With Uneepac, you can achieve high-efficiency sealing with fewer rings, smaller stuffing boxes. For quick, easy installation, Uneepac rings are self-centering, self-adjusting. Make it a point to consider Uneepac Rings for every application requiring top packing efficiency and life.

Uneepac rings are available in all standard materials in a wide range of sizes for most rod and plunger applications. For further information, write to Johns-Manville, Box 14, New York 16, N. Y.

J-M Clipper Seals—used as rod wipers in BE-GE cylinders—keep dirt out.

JOHNS-MANVILLE

FACTS about Norgren MICRO-FOG LUBRICATION



Norgren MICRO-FOG lubricates all bearings, gears and other components on this turret lathe.

Continuous, Automatic Lubrication for Bearings*... Oil Always Fresh and Clean

- ***Bearings given Ideal Lubrication***—Just the right amount of oil is applied to provide the best possible lubrication. Bearings run cooler by as much as 20° F. Bearing wear is minimized, reducing maintenance and replacement costs.
- ***Saving in Lubricant is Big***—Using only a few ounces of oil per day, MICRO-FOG provides more thorough lubrication than other methods using considerably more.
- ***Costs for Equipment are Less***—Sumps, pumps, oil filters and high pressure piping are all eliminated by MICRO-FOG, providing a big cut in equipment requirements. Also, fewer oil seals are needed, reducing costly maintenance and down-time.

A MICRO-FOG Lubricator creates an air-borne fog of extremely fine particles of oil that can be appropriately distributed to all lubrication points of even a large machine, automatically lubricating with a continuous, fully protective film of fresh, clean oil.

*Also provides ideal lubrication for gears, chains, cams, slides, ways and other machine components.

For complete information, call your nearby Norgren Representative, or write for NEW No. 900 CATALOG.

C. A. NORGREN CO.

If it's Norgren... It's Dependable.

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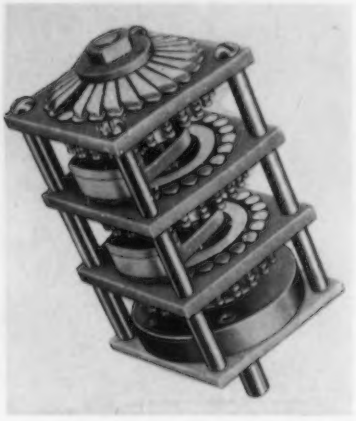
current continuity. Electrical connections are made by eyelet connectors on wires and secured by locknuts. Rated at 10 amp, 125 v ac; 5 amp, 250 v ac. Switches are 49¢ each in 10,000 quantities. **Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill.**

Circle 29, inside back cover



Progressive shorting switch . . .

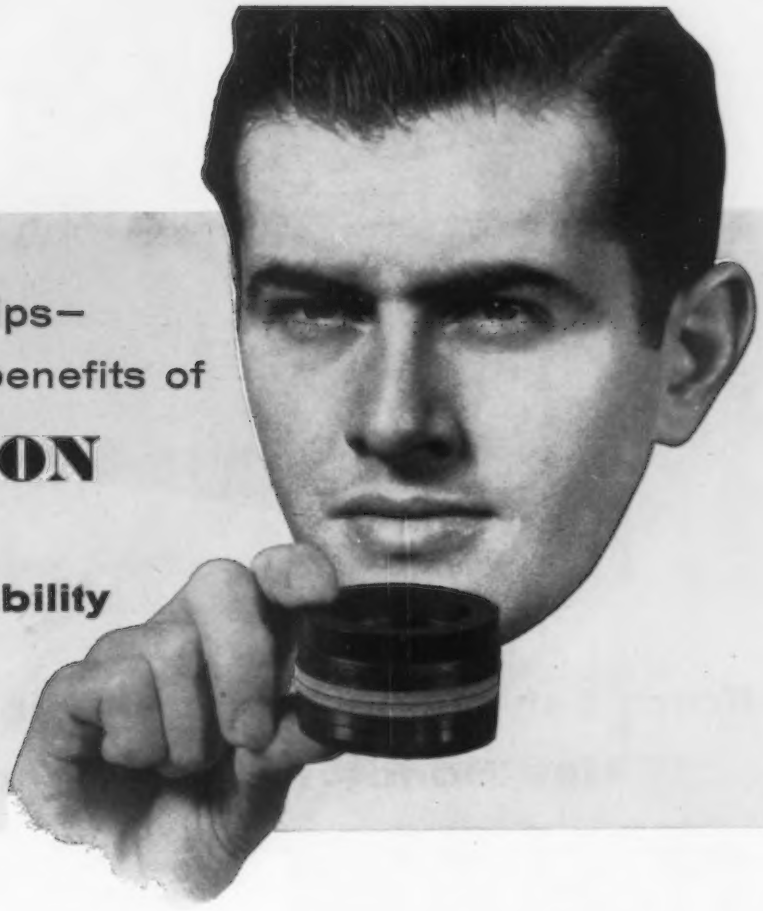
assures that only desired position is in operation at any one time. Shorts out every other position on switch but the one actually in use. Also, switch's separate ring connection makes possible switching one meter between every position consecutively, continuous programming and other special applications. Available as 20, 24 and 32-pole units, the switches can be ganged for multiple-deck application. Solid silver alloy fingers, designed for self-wiping action ensure low and uniform contact resistance. Contact materials and slip rings are solid silver alloy. Applications include capacitor decade switching, sequential power distribution, ammeter switching, voltmeter switching, control decks for rotary-solenoid operation and network sequencing. **Daven Co., Livingston, N. J.**

Circle 30, inside back cover

Servoamplifier for valves . . .

in pneumatic or hydraulic systems is transistor-equipped. Each amplifier includes an isolated ac power source, and summing networks allow amplifier to accommodate wide range of feed-back and control signals. Circuit is said to contain no critical components that might change with time. Front panel contains a meter for continuously monitoring system balance and response. Package uses 3½ x 19 in. of panel space. Operates in ambient temperatures of 0 to 120 F with free air circulation. Power required is 115 v ac, 60 cps, 25 w. Quiescent output current is 150

(Continued on page 120)



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HOUGHTON

"V" Packing Interchangeability

COMPLETE INTERCHANGEABILITY among Houghton leather, rubber, and fabric "V" packings provides users the solution to a long-standing problem—the choice of packings for an application that demands properties no single packing material can provide.

Now, the identical stack heights of all Houghton "V's" permit *unlimited* switching of "V" combinations in any gland, either with sets of the same material, or among units of different materials within a set.

You can use a leather "V" for anti-extrusion, strength, and low friction, with a rubber unit for wiping efficiency and low cost. You can switch from rubber to a fabricated unit to gain extra strength. You can even use all three "V's" in one set, all in the same gland.

Houghton interchangeability of packings is a terrific advantage to designers who specify gland size according to J. I. C. Standard Stack Heights. New efficiency, better sealing, better performance result because you can mix packings any way you wish—get the exact kind of seal you wish.

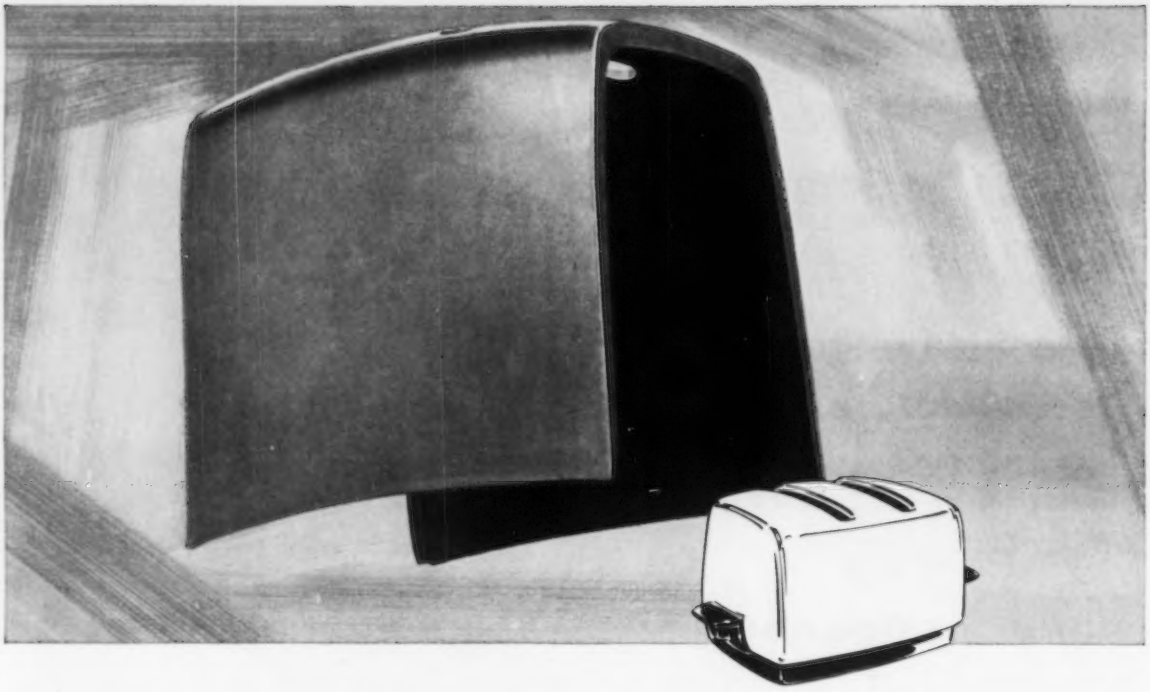
Ask the Houghton Man . . . or write E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.

"V" PACKINGS . . . *products of* . . .

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .



Form flat-polished metal without marring!

Use Bonderite and Bonderlube

Multiple head flat polishing at Production Finishing Corporation, Detroit.

Polished sheets are treated with Bonderite and Bonderlube before forming.

Bonderite and Bonderlube protect that smooth, flat-polished finish through forming and fabricating. Parts go direct to the plating bath from forming operations with only a light buffing.

All types of products are being made this way—automobile bumpers, automotive trim, toaster and small appliance bodies, home laundry equipment components and many other formed parts.

Cost reductions are big with Bonderite and Bonderlube: Polishing costs on bumpers went from 9c a square foot for contour polishing to 0.8c a square foot for flat polishing before forming. Savings of 10c to 30c a square foot have been reported by other industries.

The Parker technical representative has full information on this cost-cutting combination. A letter or phone call will bring it to you.

Since 1914— leader in the field

PARKER RUST PROOF COMPANY
2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

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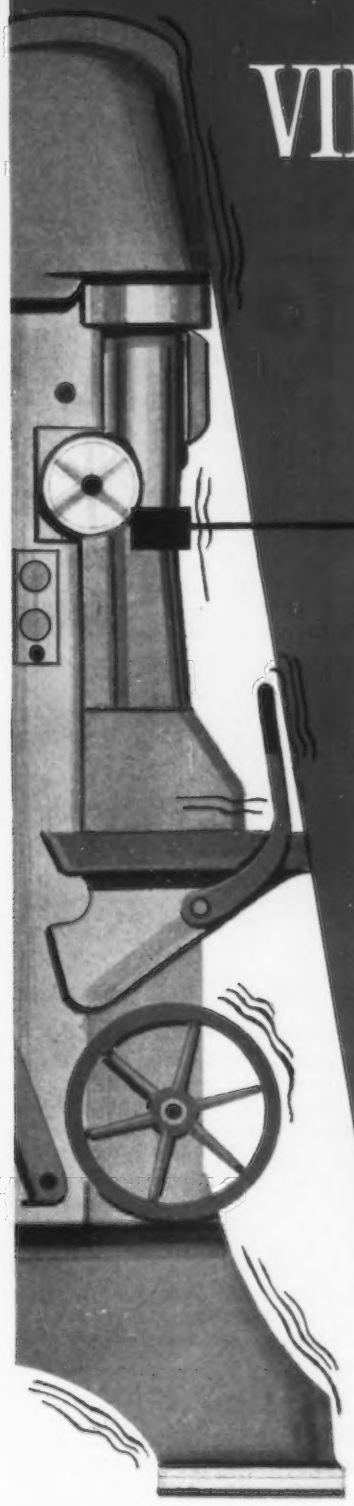
VIBRA-MOUNT FELTS



SOLVE TOUGH VIBRATION PROBLEMS!

Durable American Felts Eliminate Up To 85% Of Transmitted Vibration

Vibra-Mount Felts are used as base supports to level and isolate vibrating machinery . . . as insulating materials with which to protect sensitive instruments and equipments. In terms of operating efficiency, these resilient Felts eliminate up to 85% of normally transmitted vibration . . . in most cases no bolts or lags are needed to hold machinery in place.

Vibra-Mount Felts are inexpensive, easy to install . . . cut to fit and they are ready to apply with attached adhesive . . . can be reused for even greater economy.

Standard Vibra-Mount Felt pads fit all conventional needs . . . consult our Engineering Staff for special requirement data . . . for standard Vibra-Mount information, write for Data Sheet #10, on company letterhead please.

Remember: American Felt Company provides the largest and best equipped staff of product engineers in the Felt industry with *engineered* materials for seals, wicks, filters, insulation, decoration . . .

General Offices and Engineering and Research Laboratories
78 Glenville Road
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TRADE MARK

PRODUCTIVITY?

There is untapped productive potential in the existing machinery in most plants. When these same machines are equipped with the Sterling Electric Power Drive System, recommended by a Sterling Application Engineer, you will get the full productive capacity they were designed to deliver.

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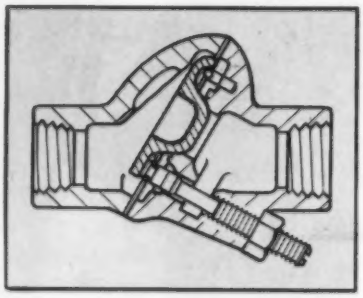
ma per coil in push-pull into about 50 ohm coils; max coil resistance is 75 ohm; differential current is 0 to 300 ma. Ac sensitivity is approximately 200 ma differential current per 0.05 v rms input into 100,000 ohm impedance. **Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 54.**

Circle 31, inside back cover

Transistor amplifier . . .

delivers 500 milliw output, phase sensitive dc or ac, throughout entire temperature range of —67 to 257 F. Suited for driving electrically operated hydraulic valves, relays, magnetic amplifiers, small motors, or power amplifiers in compact, limited space equipment. Weighs less than 5 oz; occupies 5 cu. in. Unit consists of a voltage and current amplifier followed by a phase discriminator stage, designed to operate from a single external power source. Input signal may be a square or sine wave. Voltage required is 115 v at 400 cps. Withstands 10-g shock, vibration, and meets military specs. **Precision, Inc., 730 Lyndale Ave. N., Minneapolis.**

Circle 32, inside back cover



Flow control valve . . .

for air, gas or low-pressure hydraulic flow has unrestricted return. Lower range of flow rates is metered by adjusting position of threaded stem within a concentric bore in valve body. Flow is then controlled by clearance between flapper and seat. Principal flow-rate adjustment is by external locknut on slotted adjusting stem. Offered in ¼ through ¾ in. NPT sizes. Valve body is cast Navy M bronze, stem is stainless steel, flapper is molded nylon. An O-ring seals and retains the stem. **Valvair Corp., 454 Morgan Ave., Akron, Ohio.**

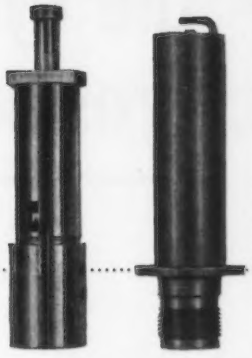
Circle 33, inside back cover

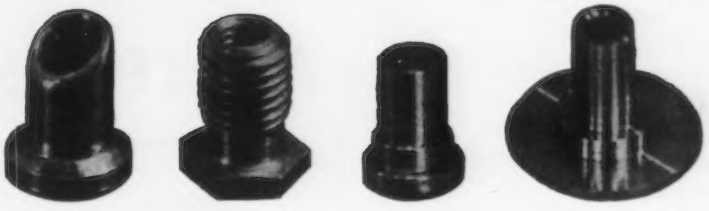
Tiny transistor amplifier . . .

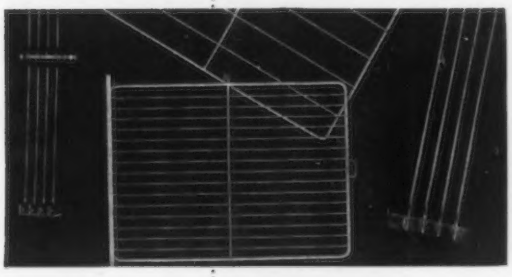
has a 20 db closed-loop ac gain, stable within 10% from —76 to 320 F. Operates from a single 28-v power supply. No microphonic noise is said to be observable to 400 g at 2000 cps. Incorporates five

(Continued on page 124)

If you use STAINLESS BARS or WIRE...







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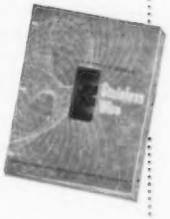
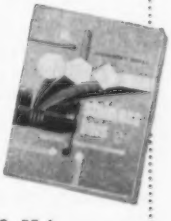
ALLEGHENY STAINLESS WIRE

Illustrated 20 page booklet, which fully describes analyses, physical properties, corrosion resistance, principal uses and applications of stainless wire.



ALLEGHENY STAINLESS BARS

Illustrated 28 page booklet, which fully covers alloy selection, fabrication, annealing, heat treating, corrosion resistance and weight of stainless bars.



ADDRESS DEPT. PE-4

Whether you use stainless bars and wire to provide lasting, easily-cleaned sparkle for refrigerator shelves, to stand up under the metal-torturing heat of a jet engine or to meet any requirements of resistance to corrosion, heat, wear or great stress, you'll find that the combination of Allegheny Stainless Steel and Allegheny Ludlum technical assistance can offer distinct production advantages that will help your competitive position.

The wide variety of grades, shapes, sizes and finishes of Allegheny Stainless Bars and Wire assures you of ready availability of the material you need. And you can count on the assistance of our Technical Staff with the problems of application and fabrication—to help reduce your machining, welding and finishing costs. Let us work with you.
Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.

Make it BETTER and LONGER LASTING with

ALLEGHENY STAINLESS

WSW 6490

AL

ALLEGHENY LUDLUM

Warehouse stocks carried by all Ryerson steel plants

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Gold color finish attracts the eye and repels corrosion

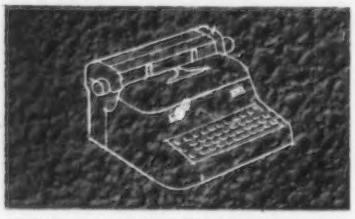
Vinyl finish sprayed to look like morroco leather

Something new for product designers is Unichrome Coating 6400 — a textured, highly mar-resistant protective finish. It can add distinction and durability to any product. It has a costly grained leather look, yet is applied by spray, in thicknesses of up to 20 mils per coat.

WITHSTANDS ABUSE

This finish is hard yet flexible. By as much as 10 to 1, it outlives ordinary textured enamels under abrasive and abusive service conditions. Taber abrasion tests show only 35 mg. loss in 1000 cycles vs. 350 mg. for the enamels.

Being a vinyl finish, Coating 6400 withstands chemicals, corrosives, moisture. It doesn't stain, is easy to clean. The surface can be varied from matte to gloss. It also insulates electrically, and helps to muffle sound. Send for new bulletin.



With this textured decorative and protective coating, products get the quality finish that befits them.

METAL & THERMIT
CORPORATION

General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit–United Chromium of Canada, Limited, Rexdale, Ont.

Products finished with M&T Bronze rival gold in appearance, in consumer appeal. Applications are wide as a designer's imagination.

M&T Bronze plating process produces uniform copper-tin plate at high speed

All may not be true gold that glitters, but improved M&T Bronze certainly is the image of the 24K kind.

This distinctive bronze is 88% copper, 12% tin — with uniform color and coverage even on complicated shapes. The finish reflects more depth and character than brass plate; demonstrates more durability than copper. It is a one plate finish, more economical than the copper-nickel-gold it has replaced on trophies, for example.

DURABLE FINISH

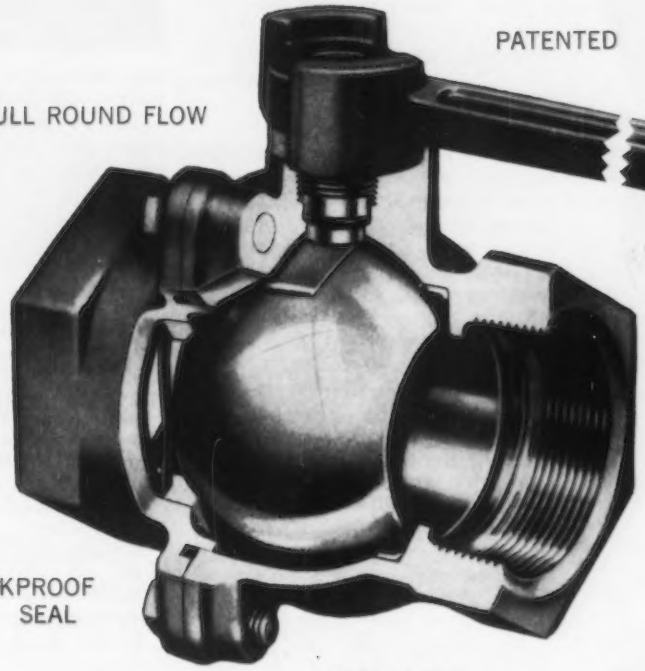
M&T Bronze, in addition to its eye-appeal, offers corrosion resistance superior to that of copper. A clear lacquer or synthetic applied on top of this plate will assure the long, tarnish-free life expected from a quality finish.

ECONOMICAL FINISH

In overall economy, the M&T Bronze process does better than gold or brass plating and rivals copper. It can save production time, being able to plate as fast as one-tenth mil in one minute.

EASY TO USE

Since the M&T Bronze Process is as easy to control and to operate as those depositing single metals, it assures consistent results. It can be plated matte as well as mirror-bright, or anywhere in-between. Send for data.



Who sends Valentines to a Rockwood Ball Valve?

Rockwood Ball Valves are operating, without leakage, in plants throughout the country, and the pleased comments we receive read like valentines:

A brewing company has opened and shut their Rockwood Ball Valves over two million times — and their valves are still going strong!

An oil company was surprised (although we don't know why — it's a common occurrence) when Rockwood Ball Valves stopped leakage other valves could not stop.

A company boiling starch found Rockwood Ball Valves lasted longer than any other valve previously used.

A tannery tells us Rockwood Ball Valves are the quickest, easiest valves to open and close.

Frankly, we can't blush — it would be false modesty. Rockwood Ball Valves are perfect for many jobs — we build them that way. They come in all pipe sizes, rated at 300 W.O.G. Tell us where to send it — and we'll give you a booklet with complete information. Valves are tested and listed by Underwriters' Laboratories, Inc. Distributors in principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2251 Harlow Street
Worcester 5, Mass.

Please send me your illustrated Rockwood Full, Round Flow Ball Valve folder.

Name.....

Title.....

Company.....

Street.....

City.....*Zone*...*State*.....

components. Size is ¼ x ⅜ x 1½ in.; weight is 0.4 oz. Designed for servo, audio and pulse applications. Priced at $140. **Taber Instrument Corp., N. Tonawanda, N. Y.**

Circle 34, inside back cover

Hard acrylic enamels . . .

for interior use have been added to basic line of thermosetting resins. Baking schedules are 30 min at 350 or 300 F or equivalent, depending on type. Can be used as a single coat. Suggested as a one-coat enamel for freezers, driers, industrial products or as a topcoat with various primers to obtain advantages over present baking enamels at no increase in cost. **Pittsburgh Plate Glass Co., 632 Fort Duquesne Blvd., Pittsburgh 22.**

Circle 35, inside back cover

Motor-speed control . . .

operates from 115 or 230 v ac power supply. Variable-speed drives utilize dc motors and operate them from ac power sources. Voltage is varied before rectification and only the actual power required is transmitted. Silicon rectifiers are used. A switch actuates control as dial is turned. Further rotation increases speed. Remote control is possible because control unit can be mounted in any position at any required distance from motor. Can be furnished for fhp to 20 hp using specified dc motors. **Carpco Mfg., Inc., P. O. Box 3272, Jacksonville 6.**

Circle 36, inside back cover

Bearing tester . . .

determines performance qualities of oil-lubricated, instrument-size ball bearings. Now being used, too, for pre-assembly performance checks and for diagnosing bearing malfunctions. Tester has an average hourly production rate of 60 to 100 bearings. Tests at various assembly stages can be used to point out specific operations responsible for dirt, contamination or damage to bearings. Can be set up in 10 to 15 min, including calibration.

(Continued on page 125)

Eliminate "high-cost specials" by standardizing on

AMERICAN STOCK GEARS

Investigate and you'll probably find that instead of having to go to the added time and expense of ordering special gears, that your needs can be filled from the American line.

American is a complete stock gear line. It includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in a range of 48 to 3 diametral pitch. Available from your nearby distributor of American Stock Gears.

Ask for FREE copy of American Stock Gear Catalog No. 360 containing detailed information and engineering data.

AMERICAN STOCK GEAR
division
Perfection Gear Co., Harvey, Illinois

HOW
BORG EQUIPMENT DIVISION
CAN HELP YOU

Our business is helping to solve design and production problems in the use of components for the highly specialized electronics industry. Borg's background provides the experience necessary to design and produce various types of components for you . . .

MICROPOT* POTENTIOMETERS
Borg Micropots offer a wide range of high-precision, single-turn, multi-turn and trimming potentiometers.
**Registered trademark of The George W. Borg Corporation.*

MICRODIALS
Direct Reading Microdials and Concentric Scale Microdials.

INSTRUMENT MOTORS
Rugged, dependable Borg-Motors are designed for quality instrument applications.

AIRCRAFT INSTRUMENTS
Instruments for commercial and military aircraft.

FREQUENCY STANDARDS
To meet your requirements in Frequency Standards for military or industrial applications.

TEST EQUIPMENT FOR AUTOMATION
Invaluable experience with automatic testing equipment is yours when you call on Borg.

Save time and money when faced with design or production problems of electronic components. Call on Borg. Let us send you the name of your nearest Borg "Tech-Rep" and a copy of catalog BED-A90 today.

OTHER BORG DIVISIONS

The George W. Borg Corporation is comprised of three divisions . . . the Borg Equipment Division at Janesville, Wisconsin, the Borg Fabrics Division at Delavan, Wisconsin which manufactures the fashionable "Borgana" fabric for coats and jackets and the Borg Products Division at Delavan, Wisconsin, leading manufacturer of automotive clocks.

BORG *Built by Borg*
MOTORS
MICROPOTS
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PRODUCE YOUR PRECISION INSTRUMENTS AT LOWER COSTS With

BORG 1100 SERIES MICROPOTS

Cut production costs . . . gain both price and quality advantages in your competitive markets! Borg 1100 Series MICROPOTS give you quality potentiometers at competitive prices. Write today for name of your nearest Borg Jobber or "Tech-Rep"!

ENGINEERING MAKES THE DIFFERENCE:

- Lug type terminals or coded flexible leads!
- Two bearing supports . . . 1½" minimum between bearings!
- Optional rear shaft extension!
- Production quantities available!
- Precision fabricated parts give permanent accuracy!

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MOTORS
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BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

Results are directly in units related to limits established by user. Test indications are repetitive, and differences in operators' techniques or judgment are said not to affect ratings. **The Barden Corp., Danbury, Conn.**

Circle 37, inside back cover

Adjustable-speed drive . . .

operates from alternating current, eliminating current-conversion equipment. Connected directly to load, unit requires no belts or clutches. Speeds can be selected or changed while equipment is idle or in motion, manually or automatically by remote control. Desired speed, after selection, remains constant regardless of fluctuations of load or temperature changes of equipment. Consists of an induction motor, control switch and cabinet. Available in 1 through 50 hp, with max speeds of 3400, 1700, or 1130 rpm. Standard drives are 208, 220, 440 or 550 v, three-phase, 60 cps. **VarEPack Div., Electric Products Co., 1725 Clarkstone Rd., Cleveland 12.**

Circle 38, inside back cover

Indicator-light capsule . . .

has a translucent strip that displays warnings in words or code visible only when two AN3140-327 lamps are energized. Rear of capsule contains a switching mechanism that enables unit to be used in a master annunciator or monitoring system. Upon receipt of a signal, the unit will reset a master light or bell, or automatically dim to an intensity suitable for night visibility. Unit is 2⅛ x 0.832 x 0.400 in. high. **Radar Relay, Inc., 2120 Pontius St., Los Angeles 25.**

Circle 39, inside back cover

Angled pen nib set . . .

draws or matches ink lines 0. 3 to 2.5 mm. Offset of interchangeable nibs permits them to hug guide-slot walls, regardless of curves. Master kit, which includes nibs, holder and self-regulating ink feed, is $15. **Laramie Chemical Corp., 290 Main St., Stamford, Conn.**

Circle 40, inside back cover

Reprints of two articles . . .

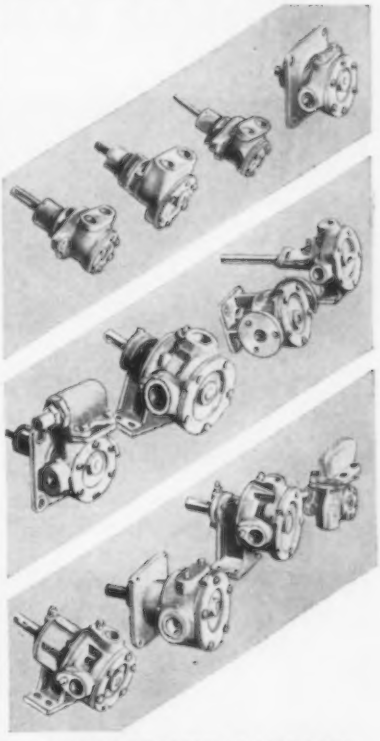
in this issue are now ready for distribution, and single copies can be obtained by readers in U.S. and Canada at no charge as long as the supply lasts. Use one of the Reader Service cards to request your copies of:

Silicone Rubber Parts
Circle No. E20

Pressure Drops in Air Valves
Circle No. E19

For free reprints from earlier issues see complete listing on page 147 in this issue.

WHAT PUMP DO YOU NEED?



VIKING DESIGNS PUMPS TO FIT YOUR SPECIFICATIONS

CHECK VIKING Pumps when you are designing equipment that requires positive lubrication, a flow of coolant, or the transfer of a liquid or semi-solid. Viking Pumps, designed to fit your equipment, can help you save space ...plan more efficient operation... and, in many cases, cut costs of equipment.

SEND VIKING YOUR PROBLEM
CLIP THIS COUPON

Please send me your suggestions.
I have the problem of incorporating a pump in

for handling
at G.P.M., under psi
Name
Address
City State

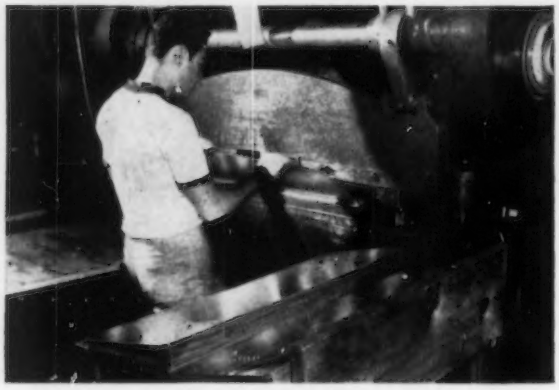
and Mail to Department X

VIKING PUMP CO.
Cedar Falls, Iowa, U.S.A.
In Canada, it's "*ROTO-KING*" pumps
See Our Catalog in Sweet's Product Design File

Production Takes A Short-Cut

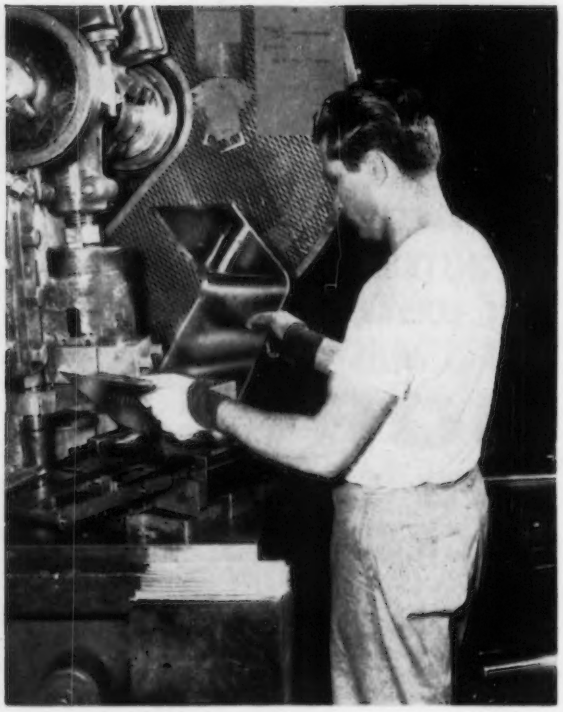
With Pre-Plated NICKELOID METALS

Sheet of Nickeloid chrome-steel that will be used for breadbox is blanked, with punch-out perforations for ventilation and indented shelf supports. Uniform pre-plated finish reduces rejects.



Edges of Nickeloid chrome-steel sheet are turned up 1/2" in forming press. Nickeloid is easily worked with standard methods.

Breadbox body frame is spot welded to the preformed bottom and back pieces, with no visible oxidation. Parts then move to assembly.



Two bends are made on press to give the breadbox its rectangular shape. Operation causes no marring of surface or dulling of finish.

No Cleaning or Post-Plating — Easily Worked With Standard Production Methods

No cleaning solutions, plating tanks or polishing wheels on the production line at Lincoln Metal Products Co., Brooklyn, N.Y., manufacturer of fine pantryware. Lincoln eliminates these costly intermediate steps by using Nickeloid pre-plated chrome-steel and copper-steel. These versatile design materials speed trouble-free production, reduce rejects, prolong tool life. They are readily worked with standard production methods, as shown here. Parts move from fabrication — to assembly — to packing, with no dulling or marring of the pre-plated finish, since Mar-Not protective covering is used. No cleaning, plating, polishing is needed. Nickeloid Metals are available in pre-plated finishes of chrome, nickel, copper or brass on steel, zinc, copper, brass and aluminum. Sheets, strips, coils — a wide range of finishes and patterns.

Write For Free Literature

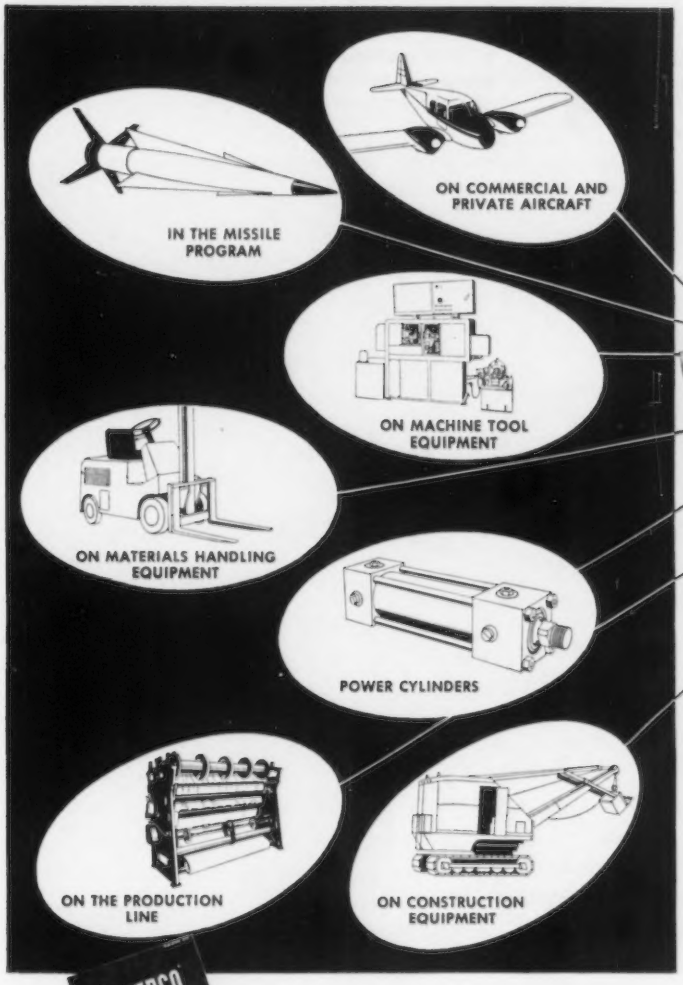
NICKELOID METALS SINCE 1898

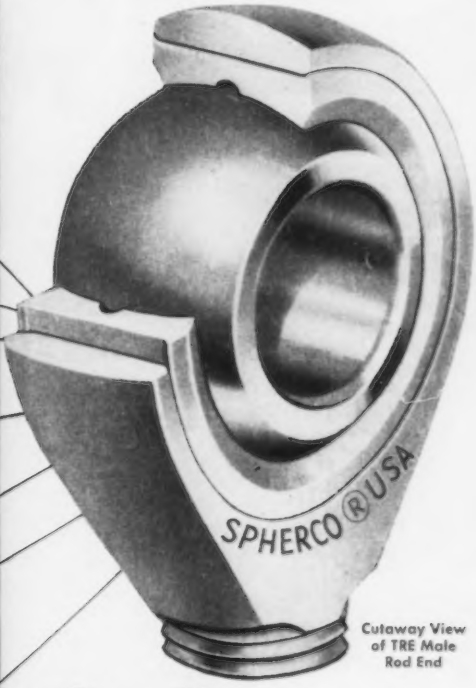
AMERICAN NICKELOID COMPANY

Peru 4, Illinois

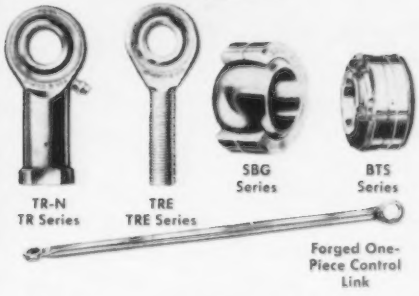
SPHERCO® Spherical Bearings and Rod Ends

FEATURING SOLID RACE DESIGN FOR OUTSTANDING PERFORMANCE!





Cutaway View of TRE Male Rod End



Write today for your copy of Bulletin 257.

Wherever you find the trademark SPHERCO on a spherical bearing or rod end, you can be certain that here is engineering ahead of the field . . . quality control exercised with the finest care . . . supplier-customer engineering co-operation that solves problems before they arise . . . modern production facilities that assure quality in quantity to meet rigid customer schedules. SPHERCO Bearings and Rod Ends are available in a wide range of designs, bore diameters, selection of materials and thread sizes.

If you have a special spherical bearing problem, refer it with confidence to a SPHERCO sales engineer.

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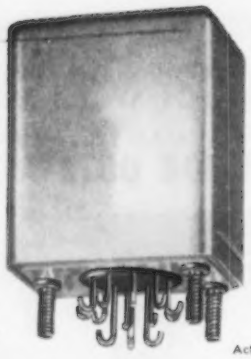
BEARINGS & ROD ENDS

product of SEALMASTER BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.

MAIN OFFICE AND PLANT: 9 RIDGEWAY AVENUE • AURORA, ILLINOIS

NEW RBM

BHSM and BHSM HT TYPES



Actual Size

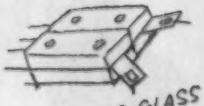
Miniature Hermetically Sealed Relays

The reliability of this relay under severe conditions of vibration and shock has been field-proven in many applications. It is another example of how R-B-M's production maturity and complete facilities can eliminate many of your engineering problems.

WITHSTANDS 10g – 500 CYCLE VIBRATION

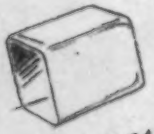
"RUGGEDIZED" WELDED RELAY AND BRACKET ASSEMBLY

DEPENDABLE X-BAR CONTACTS



SILICONE-GLASS PILE UP INSULATORS (HT VERSION)

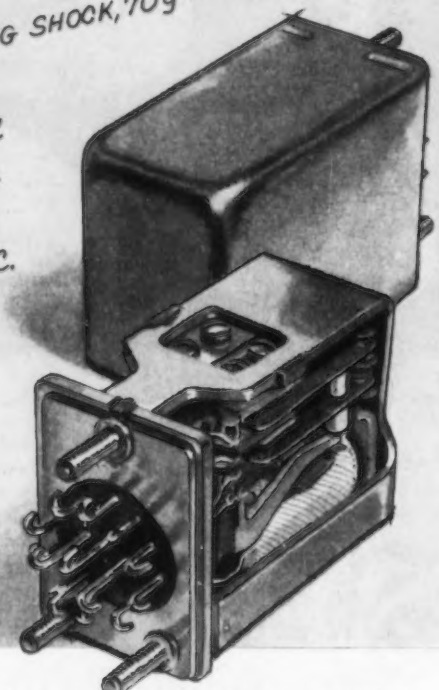
KEL-F COIL BOBBIN AND TEFLON MAGNET WIRE (HT VERSION)



HERMETICALLY SEALED OR DUST COVER AVAILABLE

OPERATING BENEFITS

- 125°C OPERATING AMBIENT
- TEMP. RANGE } 22700 BHSM TYPE, -55°TO+85°C 22800 BHSM HT TYPE, -65°TO+125°C
- COIL UP TO 130 V.D.C. } SENSITIVITY 0.2 W. MIN. PER POLE MAX. COIL DISSIPATION 3.75 W.
- CONTACTS-MAX. 4 PDT 3 AMP. AT 32 V.D.C. OR 115 V.A.C. (NON-INDUCTIVE)
- SPECIAL CONTACTS AVAILABLE FOR LOW LEVEL OR DRY CIRCUIT APPLICATIONS
- APPROX. WEIGHT - 3.25 OZ.
- 30g OPERATING SHOCK, 70g NON-DESTRUCTIVE



Consult your local RBM Product Application Engineer or write for Bulletin BHSM-1.

RBM Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 137.

NYLON PARTS SAMPLE KIT—Assortment of injection-molded nylon parts for use in experimental work is offered to design engineers. Nylomatic Corp., 107 W. Trenton Ave., Morrisville, Penna.

Circle 41, insidee back cover

PERMANENT MAGNETS — Bulletin 158, 20 pp. Covers applications, fundamental properties, design problems, magnet testing, magnetic attraction, mechanical considerations and stabilization and magnetization of finished magnets. Thomas & Skinner, Inc., 1178 E. 23rd St., Indianapolis 7.

Circle 42, inside back cover

STAMPED GEARS—Booklet, 20 pp. Lists major applications, size limits, materials and finishes and illustrates typical examples. Information includes gear-design suggestions, tips for time saving and avoiding errors in selection, and basic gear dimension data. Also, has full description of anti-backlash feature, and gear-tooth formulas and terms. Fastex Div., Illinois Tool Works, 195 Algonquin Rd., Des Plaines, Ill.

Circle 43, inside back cover

VALVES—Bulletin B-2, 20 pp. Illustrates valves with 600, 1500 and 2500-lb ASA ratings. Valves are stainless steel, Monel or other corrosion-resistant materials. With dimensional drawings, cutaway diagrams and tabulated specs. Associated Valve & Engineering Co., 1150 W. Marquette Rd., Chicago 21.

Circle 44, inside back cover

HYDRAULIC SPEED CONTROL—Bulletin FP-1217, 4 pp. Describes and illustrates lever-type governor for variable or constant-speed service. Gives dimensions, installation and operating instructions and lists parts. Includes all specs. Farris Pickering Governor Co., Inc., 400 Commercial Ave., Palisades Park, N. J.

Circle 45, inside back cover

RINGS, BANDS AND WELDED ASSEMBLIES—Catalog, 20 pp. Illustrates products produced by the firm. Sections are devoted to titanium and aluminum rings, carbon steel rings, stainless steel and special-alloy rings, precision rings and special fabrications. Special services and the firm's use of mill-rolled or extruded sections in flash-welded rings are described. American Welding & Mfg. Co., 101 Dietz Rd., Warren, Ohio.

Circle 46, inside back cover

SECTION V-BELTS—Booklet, 6 pp. Describes and illustrates detachable and adjustable belt. With specs, selection tables and dimensional drawings. R & J Dick Co., Inc., Box 388, Passaic, N. J.

Circle 47, inside back cover

SPECIAL PROPERTY PLASTICS — Brochure, 6 pp. Physical and chemical properties of six special clear-plastic materials and a coating material for emergency repairs. Homalite Corp., Wilmington 4, Del.

Circle 48, inside back cover

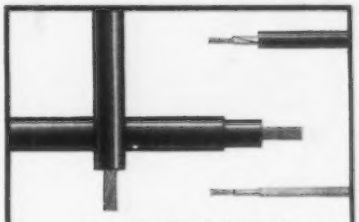
PLATINUM PRODUCTS—Brochure, 20 pp. Shows some of the end uses of small-diameter stainless steel, nickel and nickel-alloy tubing. Includes illustrations and dimensional drawings, notes on the use and care of platinum ware, and tables giving conversion factors, physical properties, weight, area and circumference and other data. J. Bishop & Co., Platinum Works, Malvern, Penna.

Circle 49, inside back cover

CARBON AND GRAPHITE BRUSHES—Bulletin, 12 pp. Describes and illustrates line of brushes for rotating electrical machinery. Gives data on brush selection, specs and performance. A table summarizes brush grades by group, grade,

(Continued on page 133)

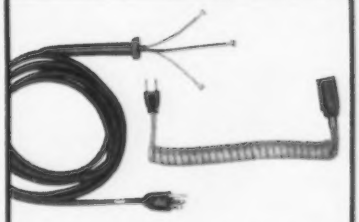
They can be your design assistants on other Essex Engineered Products.



WIRE AND CABLE

These "power full" lead, appliance, electronic, Sil-X 200°C and the Mil-W-76-A and Mil-W-16878 govt. spec. wires are standard—save industry special engineering, source and delivery problems.

Wire and Cable Div., Ft. Wayne, Ind.



COILED CORDS-CORD SETS

Prime source for plastic and rubber power supply cords. Terminations of all types (molded plastic and rubber) with infinite design possibilities. Complete line of Coiled Cords including HPN.

Cords Limited Division, DeKalb, Ill.

TYPE MS RELAY

A low cost, space saving single pole or common multiple contact D.C. unit. Highly reliable. Can be built to withstand extreme environmental conditions.

R-B-M Control Div., Logansport, Ind.

ESSEX
WIRE CORPORATION

We took a tip from a typist

The question came up at a Heads-of-Departments meeting. Production told Personnel that his new typist asked that a portion of her salary be set aside for U. S. Savings Bonds. Could it be arranged?

This one question posed another: How many more employees, like the typist, would like to buy Savings Bonds automatically through Payroll Savings, yet, were not aware that we've had a Plan for years?

Finding out was simple.

A phone call brought the assistance of our State Savings Bond Director. He helped plan a company-wide campaign, and provided all the materials to inform our people about the advantages of U. S. Savings Bonds. Everyone received an application card.

The upshot? Employee participation shot up to the highest percentage since the mid-Forties. And the whole program was conducted in good order. Work was never interrupted.

Today there are more Payroll savers than ever before in peace time. Look up your State Director in the phone book or write: Savings Bonds Division, U. S. Treasury Dept., Washington, D. C.

PRODUCT ENGINEERING

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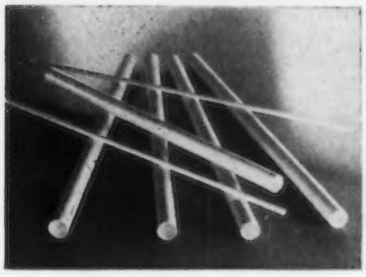
THIS IS GLASS

a bulletin of practical new ideas from Corning



News! PYROCERAM brand Tubing and Rod now available.

We flatter ourselves into thinking that a great many of you are familiar with PYROCERAM Crystalline Materials.

For the sake of review, however, this brief summary: PYROCERAM is the brand name given by Corning to a new group of ceramic crystalline materials made from glass. What with *nucleating* agents and some classified heat processing we end up with a material *unlike* anything you've ever seen. A number of variations, each exhibiting different *combinations* of properties, have been evolved.

On an overall basis, PYROCERAM Materials can be made lighter than aluminum; harder than carbon steel; stronger than tempered glass; immune to the corrosive action of most chemicals; unbothered by heat that warps steel and melts copper; possessed of electrical properties equal to the better ceramics.

And now you can get one variant in the form of PYROCERAM Tubing and Rod. Designated Code 9608, it is a *gastight* white *opaque* material. It has the thermal shock resistance that you'd normally get *only* from fused silica. On the Vickers Diamond Pyramid test it rates 550.

You can use this PYROCERAM Tubing at an operating temperature of 1000°C., *unloaded*—up to 500°C., loaded. (The latter figure is based on preliminary runs with indications that it's *too low*.)

Long-term chemical durability data will be available soon. But we can tell you that linear coefficient of thermal expansion is 9-15 (factor 10^{-7}) between 25° and 300°C. Specific gravity at room temperature is 2.50.

The enthusiasm shown by you when PYROCERAM Materials were first introduced suggests that these *new* forms should prove practical in varied product and process applications. Might just be that the idea you've been noodling around can now become a *reality*.

Inquiries aimed at our Technical Products Division will bring you all the very latest data on PYROCERAM Tubing and Rod.

And for your files, there's Progress Report No. 2. Check the coupon for your copy.

LATE FLASH!

Just announced—PYROCERAM brand Cement. This is a thermal-setting solder glass originally developed for sealing the closure panel on color TV tubes.

But, it turns out to be an unusually versatile material. You can use it for sealing glass-to-glass, metal-to-metal, ceramic-to-ceramic—and *any* combination thereof.

The cement is fired at temperatures of 400-450°C.—*and the cemented parts can then be used at these temperatures!* It's suited for materials having expansions falling between 90-110 x 10^{-7} cm/cm °C.

The people who know most about this say this *devitrified* glass makes for real fine joining—especially for applications that have proved difficult in the past.

You can get more information by again referring to the coupon.

Get 'em while they're hot

This is MEALPACK, a device for keeping train travelers, among others, happy.

It was developed by MEALPACK of Evanston, Illinois, and now is used by railroads, hospitals and other institutions. Purpose? Elimination of the *costly* and *cumbersome* arrangements needed for preparing hot food while trains are *en route* or food to be distributed throughout a big building.

The approach is simple: Prepare meals in central kitchen; place in PYREX brand dish, insert dish in insulated MEALPACK container. At mealtime waiter serves hot food in the original PYREX dish. No fuss, no muss.

Backing up a bit, a PYREX glass dish was the logical choice, first, because dishes are *heat-charged* to a skin temperature of 250° F. to act as a heat-battery for each meal.

Then, *piping* hot food is placed in the dishes by workers wearing gloves. But even with all this heat there's *no* worry about a PYREX brand glass—it won't crack, craze, or change shape.

Also the glass won't alter the taste since it *neither* adds to nor takes from what you put in it.

And these glass dishes *look* like fine crystal. Yet you'll *never* have trouble with cleaning since there are no rough spots to hold food. Hot water, cleaning agents, rough handling—nothing bothers these PYREX dishes.

Clincher: When you draw on Corning's glass know-how and production facilities you can get *quantity* delivery on the items you need, *when* you need them, and at a *price* that makes the whole project worthwhile.

A goodly portion of our daily work is devoted to providing glass *components* (in almost endless variety) to people like you.

For a good picture of this operation send for: IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications"; B-84, "Manufacture and Design of Commercial Glassware."

You might also find "This Is Glass" of value. It's a 64-page word-and-picture summary of glass as a basic material of design and construction. FREE.

Corning means research in Glass

CORNING GLASS WORKS, 51-4 Crystal Street, Corning, New York

Please send me the following material: ☐ Progress Report No. 2; ☐ IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications"; ☐ B-84, "Manufacture and Design of Commercial Glassware"; ☐ "This Is Glass"; ☐ PYROCERAM brand Cements.

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industry's most versatile fasteners

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There is a PIP pin for every design requirement where the fastener must be self-locking for safety, yet have a quick-release feature for easy removal. PIP pins do away with bolts, nuts, cotter keys and other retaining devices in applications where parts or assemblies are subject to disassembly or removal for service or replacement . . . also as safety fasteners for preventing accidental or premature release of movable assemblies. PIP pins speed servicing of assemblies . . . permit quick interchange of mechanical units . . . allow fast assembly of portable equipment.

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PIP PINS ARE FAST-SAFE-ALWAYS DEPENDABLE

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Use the technical knowledge of our Engineering Staff to find a successful solution to your quick-release fastening problem.

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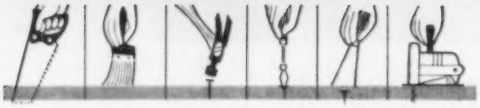
America's **NEWEST** *all-purpose building board completely fireproof— as workable as wood*



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designation and key characteristics. Speer Carbon Div., Speer Carbon Co., St. Marys, Penna.

Circle 50, inside back cover

RUBBER PARTS—Chart. Standards of dimensional tolerances, finish and inspections as applied to molded products, cut parts, rubber-covered rolls, punched parts and extruded parts in natural rubber, neoprene, nitrile rubber, GR-S, Thiokol and butyl. Williams-Bowman Rubber Co., 1945 S. 54th Ave., Cicero 50, Ill.

Circle 51, inside back cover

ANTI-FRICTION BEARINGS—Bulletin AFB-2, 24 pp. Design requirements for antifriction bearings of unusual shapes and sizes. Discusses suitable component materials for high temperatures, corrosion-resistance, nonmagnetic properties and other specialized operating conditions. Includes illustrated case histories and line drawings. Industrial Tectonics, Inc., 3686 Jackson Rd., Ann Arbor, Mich.

Circle 52, inside back cover

U-CUP PACKINGS—Bulletin AD-163, 4 pp. Describes uses, pressures, construction, available sizes and installation procedures. With dimensional drawings. Garlock Packing Co., 420 Main St., Palmyra, N. Y.

Circle 53, inside back cover

TOOLING PLASTICS—Bulletin, 4 pp. Describes use of epoxy resins in various industries. Presents basic operations carried out in the preparation of plastic tools. With explanatory line drawings. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39.

Circle 54, inside back cover

TACHOMETERS—Booklet, 12 pp. Discusses application of speed control to various industries. A series of dimensioned line drawings illustrate how units can be installed in different applications. Jones Motorola Corp., P.O. Box 825, Stamford, Conn.

Circle 55, inside back cover

COATING CHEMICALS FOR ALUMINUM—Bulletin 1424-A, 4 pp. Discusses advantages of coating, methods of application and equipment used in the processes. Lists types of metal products treated, and includes selection chart. American Chemical Paint Co., Ambler 1, Penna.

Circle 56, inside back cover

STATIONARY TACHOMETERS—Bulletin 795, 4 pp. Gives features and operational data on tachometers for permanent mounting on machines. Standard speed ranges are illustrated. Presents dimensional drawings and engineering dia-

(Continued on page 135)

"Continue to use Morganite!"

TYPICAL TEST REPORT SHOWS MORGANITE OUTLASTS OTHER MOLD MATERIALS 7 TO 1!

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"During the past 12 months, 1050 regular molds were used on the large jobs at considerable cost. These molds had an average life of 2½ hrs. on the machines for a total of 2625 hours. In the same number of hours, only 175 Morganite molds (average life 15 hours) are needed at a fraction of the cost. Substantial savings in less down time also realized. Due to mold changes, when using Morganite, another savings would be realized by saving ware now lost during such changes. Morganite ordered for use on all future runs."

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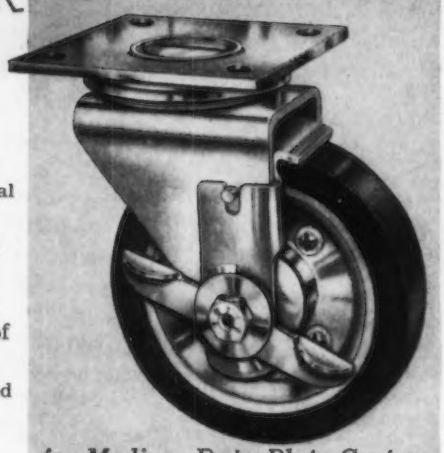

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Suitable for all 4" to 6" rubber wheels, with hard or soft tread; steel disc replaceable tread wheels, 4", 5" and 6" diameter; also medium casters with standard 4" x 4" top plate.

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grams. Herman H. Sticht Co., Inc., 27 Park Pl., New York City.

Circle 57, inside back cover

ALUMINIZED STEEL—Manual, 20 pp. Covers mechanical properties of steel, fire and corrosion-resistance, high-heat reflectivity, general properties, sizes, gages and forms, fabricating and finishing, and storing and handling. Typical uses are pictured. Armco Steel Corp., Middletown, Ohio.

Circe 58, inside back cover

SERVO BREADBOARD EQUIPMENT—Catalog, 12 pp. Covers line of servo components with photos, dimensional drawings, descriptions and specs. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N. Y.

Circle 59, inside back cover

ENGINEERING DEPARTMENT EQUIPMENT—Catalog, 24 pp. Sizes, dimensions and other specs on storage units, drawing and reference tables, all types of drafting and drawing equipment and accessories. Function, operation and construction of units are described. Stacor Equipment Co., 295 Emmet St., Newark 5, N. J.

Circle 60, inside back cover

BLIND RIVETS—Catalog and test report, 8 pp. and 3 pp. Applications, specifications and driving-sequence instructions. Evaluation report covers a test of fasteners subjected to environmental conditions in a supersonic bomber. Deutsch Fastener Corp., P.O. Box 61072, Los Angeles 61.

Circle 61, inside back cover

SOLDERLESS TERMINALS — Catalog G1, 20 pp. A digest of information in the firm's catalog series. Intended as a reference index to select the catalog with information needed by design engineers. Illustrated. Amp, Inc., Harrisburg 30, Penna.

Circle 62, inside back cover

NICKEL-PHOSPHIDE COATING — Bulletin, 4 pp. Defines process of coating from the standpoint of its alloy-bond nature, its app'ication and advantages of protection, abrasion-resistance, ductility and weldability. Included is a table of corrosive media to which coated items are resistant. Tube Reducing Corp., P.O. Box 959, Passaic, N. J.

Circle 63, inside back cover

SONIC SIFTING—Booklet, 28 pp. Discusses theory and applications of sound vibrations as applied to sifting. Describes machines available, operational details and special construction. Conversion table, screen formulas and output curves

(Continued on page 137)

ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by C. Hotchkiss, Jr.
Application Engineer,
Stow Manufacturing Company

Flexible shafting has the following advantages over other type drives:

1—it is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain

Not Collinear—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a 1¼ inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 1

Relative Motion—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a ¾ inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Company.

Fig. 2

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved—such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from ⅛ inch to 1¼ inches; for remote control applications in diameter sizes from ⅛ inch to 1⅝ inches. The 1¼ inch power drive saft will transmit up to 10 HP while the 1⅝ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering Bulletin 570.

STOW MANUFACTURING COMPANY

426 STATE STREET, BINGHAMTON, NEW YORK

Does this

PROCTOR INFINITE WATTAGE CONTROL

have a place in your product?

This Proctor bimetallic control offers... accurate, yet inexpensive control of average wattage input... new circuit simplicity . . . ease of calibration . . . full control between 6 and 100% of rating... voltage compensation at all settings except "FULL"... double line break at the "OFF" position.

A bimetal, heated by the load current, cycles between "make" and "break." The length of the "make" is controlled by positioning a figured cam. Contact action is clean without either "creep" or "snap." This is the exclusive Proctor design that makes high capacities possible.

- **These Proctor controls are small and easily installed.**
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- **Life tests up to ¼ million cycles show negligible contact wear.**
- **236 volt A.C. models are available up to 3000 watts.**
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FREE! Ask for bulletin No. G-57A, giving complete details of the Proctor Infinite Wattage Control. Write or phone for your copy today.

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Check your requirements for electric clutch and brake control. You'll find SIMPLATROL Miniature and Small Electric Clutches and Brakes upgrade new machine performance, give faster, more precise sequence operations.

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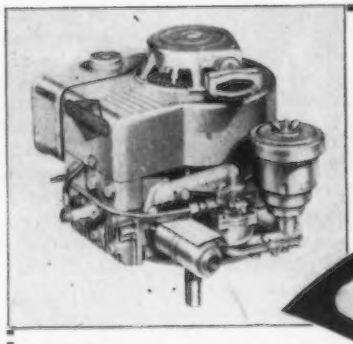

NO MOLD COST!

Reduced Unit Cost

on your initial run will effect savings for you that could very easily cover the cost of mold.

That is actually being done on many jobs similar to the starter pulley bumper (shown above) that SINKO molded for use on the Briggs and Stratton engine illustrated. Dupont ZYTEL was the plastic used because of its ability to resist wear, its quiet operation, and self-lubricating qualities.

Call on us when you're in need of Plastic Molded Parts . . . we'll produce them for you, accurately, speedily, and economically!

WE MOLD ALL THERMOPLASTICS—2 TO 175 OZ.

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Here's the answer to your Check Valve problems on submersible pumps. The taper-type rubber poppet is noiseless, can't leak, opens easily. Works in any position. All bronze body. Four sizes, 1" through 2". May be tapped for one or two side connections as shown. Used as original equipment by many leading pump manufacturers.

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are included. United Specialties Co., 9705 Cottage Grove Ave., Chicago 28.
Circle 64, inside back cover

ELECTRONIC, MAGNETIC AND ELECTRICAL ALLOYS—Booklet, 64 pp. Covers physical constants, mechanical properties, working instructions, heat treatment and corrosion resistance. Specialized data is presented on magnetic properties of high-permeability alloys, magnetic-core irons and nonmagnetic stainless steel; temperature-permeability curves of temperature-compensator alloys; temperature-expansion curves of low-expansion and glass-sealing alloys and electrical resistance of an electrical-resistance alloy. A glossary of terms is included. Carpenter Steel Co., 317 W. Bern St., Reading, Penna.
Circle 65, inside back cover

TERMINAL DESIGNS—Wall chart and catalog, 40 pp. Wall chart shows 96 turret terminals by type. Principal dimensions are shown on each. Companion catalog is tab-indexed listing of terminals and electronic hardware. With fully dimensioned drawings of all 96 terminal designs as well as dimensions of each size variation. Precision Metal Products Co., Stoneham 80, Mass.
Circle 66, inside back cover

SEMI-PNEUMATIC AND SOLID TIRES—Bulletin 714, 20 pp. Describes and illustrates tires for all types of wheel goods. Discusses features and considerations involved in selecting proper tire for given application. Tables of sizes, treads, and cross-sections are included. Ohio Rubber Co., Willoughby, Ohio.
Circle 67, inside back cover

Letterhead Requests Only

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

ALUMINUM SHEET AND PLATE—Book, 320 pp. Gives characteristics and applications of aluminum sheet and plate. Describes aluminum and alloys, how it is made, availability, physical and chemical attributes and data that will be helpful in the proper selection and use of aluminum. Includes tables of characteristics, illustrations and an extensive glossary of terms common to aluminum. Book is divided into sections with subjects indicated. Also, an index lists about 200 subjects. Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 1.

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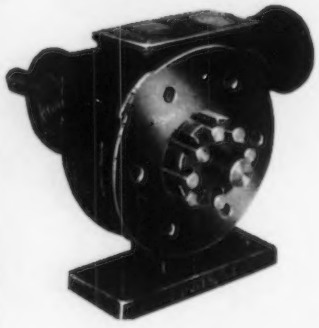

The Kraissl Class 50 roller pump is unmatched for dependability in difficult applications. The roller design will easily handle extraneous matter that would jam other mechanisms — without sacrificing suction or pressure.

Write for Bulletin A-1330

It will pay you to specify Kraissl pumps for

Machine Tools
Hydraulic applications
Circulating systems
Vacuum service
Air pressure
Industrial fuel
oil burners
. . . also strainers
and filters

Write for Bulletin A-1803

KRAISSL CO. Inc.
289 Williams Ave., Hackensack, N. J.

DESIGN ABSTRACTS

Solid Lubricant Coatings

A single, proprietary lubricant consisting of molybdenum disulfide and graphite bonded with a thermosetting resin was tested in a Falex lubricant tester at a solid velocity of 19 fpm. Data on the effects of these variables were obtained: surface finish, surface hardness, effect of pretreatment on bearing surfaces, coating one or both bearing surfaces, load, humidity, use with nylon bearings, retouching, use with oil and grease, and corrosive conditions. Interaction of these variables is complex and this study is continuing for that reason. Use of different solid lubricants in future tests is primarily expected to change data on effect of humidity.

Abstracted from "Solid Lubricant Coatings," by L. Berry, Sandia Corp., ASME paper 58-AV-20, 29 W. 39th St., New York 18.

Designing Controls for Human Use

This paper, based on published research as well as the author's own experience and speculations, identifies and discusses briefly decisive factors in control selection and design, such as which and how many limbs should be engaged, right-hand, left-hand considerations, coding, size, shape, color, control-resistance, direction and amount of movement.

Abstracted from "Designing Controls for Human Use," J. H. Ely, Dunlap & Associates, Inc., ASME paper 58-AV-10, 29 W. 39th St., New York 18.

Why Quickening Works

Electronics, electrical and mechanical means improve the closed-loop, man-machine control system because (1) amount of analog processing by humans is minimized, resulting in greater bandwidths being provided by man; (2) necessary analog computation is accomplished far more precisely than by humans alone; (3) gain factors and transfer functions of parts of system are determined by the engineer rather than by operator's trial-and-error methods: (4) effects of human "noise" are reduced; (5) effect of human gain fluctuation on systems is minimized. A description of some of the considerations involved in designing control systems of the type discussed in this paper is included.

Abstracted from "Why Quickening Works," by H. P. Birmingham, F. V. Taylor, US Naval Research Laboratory, ASME paper 58-AV-9, 29 W. 39th St., New York 18.

Mechanical Design in Aircraft

Intended to describe the role of mechanical engineering in aircraft, this paper points out that over 50% of the weight of the Douglas A3D is mechanical equipment, with the structure accounting for 44.4%, and other equipment 4%. Mechanical design philosophy and considerations are discussed, with examples drawn from nose landing gear, main landing gear, arresting gear.

Abstracted from "Mechanical Designs in Aircraft," by H. E. Cornish, Douglas Aircraft Co., Inc., ASME paper 58-AV-1, 29 W. 39th St., New York 18.

Motion and Friction in Ball Bearings

Pressure areas resulting from high speeds cause elastic deformation at ball race contact. The slippage of a ball that occurs gives rise to friction. A method is proposed for determining motion of the ball, and the sliding friction in a high-speed, angular-contact bearing under thrust load in terms of inertia effect on the ball and friction resistance developed. In some cases, solution requires a high-speed computer, in others, conventional methods of computation are frequently found to be suitable.

Abstracted from "Ball Motion and Sliding Friction in Ball Bearings," by A. B. Jones, Fafnir Bearing Co., ASME paper 58-AV-14, 20 W. 39th St., New York 18.

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of selected articles from this and other recent issues are now available in convenient reprint form. Single copies are offered without charge to readers in U. S. and Canada as long as the supply lasts. See complete listing in "Current Reprints" on page 147, and use one of the postpaid Reader Service cards to receive the copies you need.

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New method of protection incorporates corrosion inhibitors in a water-soluble polymer base. Dries to an extremely thin, tough, durable coating—clear in color. Does not chemically affect base metal or any post-treatments. Used as a protective treatment alone or to enhance value of post-treatments.

Allied's new Irilac #1000 is a concentrated solution of a water-soluble polymer with built-in complex corrosion inhibiting materials. It was developed to answer the needs of the metalworking industry for a non-conversion process that will provide corrosion resistance and resistance to fingerprinting and abrasion on base metals and electrochemically or chemically finished surfaces—without changing the appearance of the metallic surface.

There are no hazards involved—Irilac is non-fuming, non-toxic, and requires no special fire prevention measures.

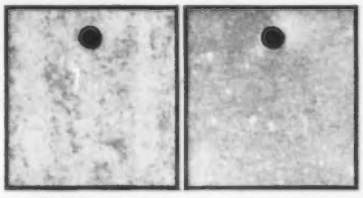
THE PROCESS

Irilac #1000 is diluted with water to provide a simple one-pass working solution. It is then applied by dip, brush or spray and forms a coating that quickly *bonds* to the metal surface without reacting with the surface.

THE PROPERTIES

The resulting coating is clear, transparent, thin yet durable. It has excellent water-resistant properties, and can be rubbed, handled and subjected to rough treatment. The surface to which Irilac has been applied is not altered—in fact, the transparent coating brings full tone to colored surfaces and clarity to iridescent surfaces. The water-thin physical characteristic of the solution means that the coating provides protection in recessed areas that are difficult, if not impossible, to protect with other methods.

STEEL PANELS: bare (left) and coated with Irilac (right) after 8-hour salt spray.



ALUMINUM PANELS: bare (left) and coated with Irilac (right) after 168-hour salt spray.

WHERE IRILAC CAN BE USED

Irilac #1000 can be applied to *any* metal—wet or dry—treated or untreated. All metals can be processed in *one* operation in the same solution. It can be applied in conjunction with any process—over Iridite, anodized, phosphated surfaces, black oxide, etc. Surfaces treated with Irilac provide a good base for paint.

APPLICATION ADVANTAGES

No other process or material available for the protection of metals offers all the application advantages found in new Irilac #1000:

1. It can be applied to *any* clean metal simply by dip, brush or spray. No special equipment is required.
2. Saves time—just apply and dry—no reaction time required.
3. No hazards involved—no exhaust or special fire protection equipment is required. Irilac is non-fuming and non-toxic.
4. Saves space. Presents no disposal problem. Low in first and final costs.

Because of its versatility and complete safety, Irilac has unlimited uses. For example, it will protect aluminum furniture, brass hardware and fixtures, steel parts of all types, zinc castings, etc. In fact, any base metal or plated surface, or those treated with electrolytic or chemical post-treatments, can be improved or enhanced with Irilac.

IRILAC #1000 MAY BE THE ANSWER TO YOUR PROTECTION PROBLEM

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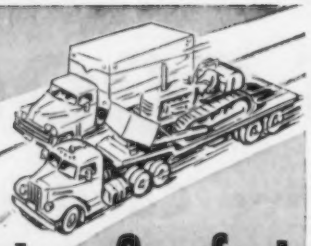

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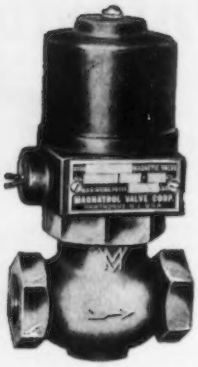

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NEW BOOKS

Industrial Electronics Handbook

R. KRETZMANN. *Published by Philosophical Library, Inc. 15 E. 40th St. New York 16.* 6x9, 300 *pp.* $12.

Written for the Philips Co. library, this is essentially a "users" book. First section discusses types of electronic tubes (not including solid-state devices) such as amplifiers, thyratrons, and photo tubes. Second section describes the most common applications for tubes—motor controls, relays and timers.

Volume offers type of information found in a good commercial tube manual, but broadened to show many examples of how tubes are used. It avoids complex mathematics and is a good book for nonelectronic engineers who want to know enough about tubes and circuits to help in making product-design decisions.

Industrial Electronics Circuits

R. KRETZMANN. *Published by Philosophical Library, Inc., 15 E. 40th St., New York 16.* 6x9, 200 *pp.* $10.

This is essentially a book full of circuits for practically every type of electronic-tube application (over 100 in all, including many photographs and performance curves). For example: timers, photoelectric sorters,

(Continued on page 143)

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profiles in plastics

by **EDWARD J. CAUGHLIN,** *President*
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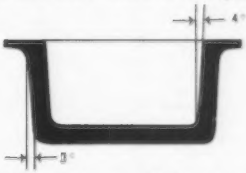

TAPER is merely one of the many important considerations of good plastics design. It is necessary on surfaces perpendicular to die parting lines to permit easy ejection. Degree of taper varies with molding process, wall thickness and material used. Taper of 3° (see example above) is considered standard. Internal wall taper for cup shaped parts should be 1° greater than external taper.

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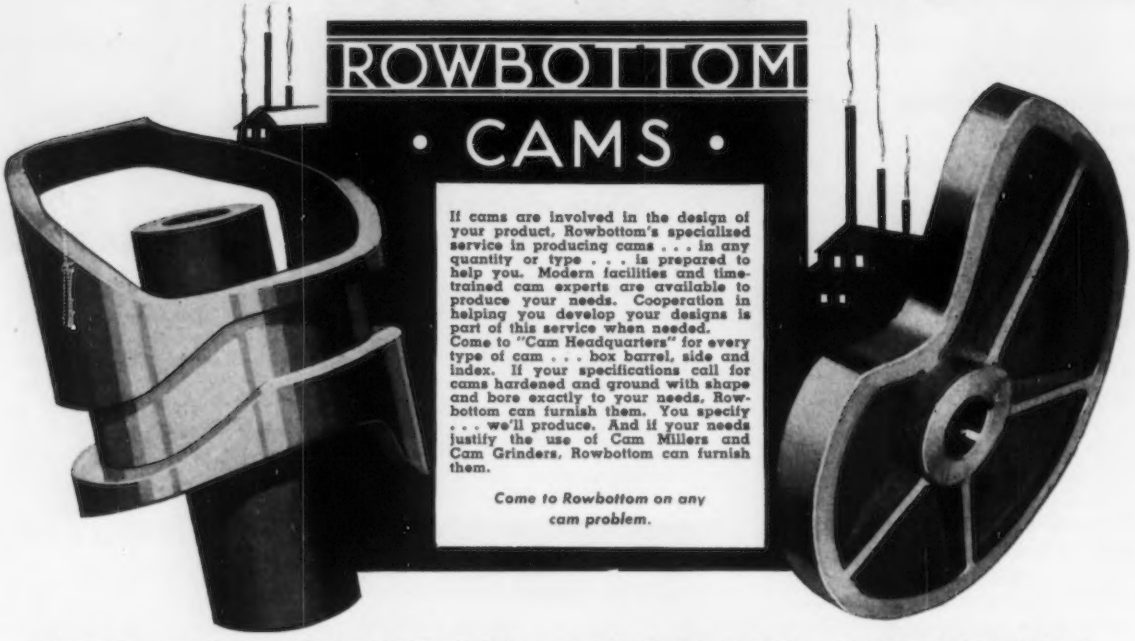
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Like the handbook reviewed above, this volume is also in the Philips library and is aimed at the nonspecialist rather than the electronics engineer.

Process Instruments and Controls Handbook

Edited by Douglas M. Considine. *Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36.* 6x9¼, 1400 pp. $19.50.

This handbook combines for the first time in one place all essential information needed by an instrument or process-control engineer to understand the tools and techniques of his profession. Especially thorough treatment is given to subjects which are so recent that previously published literature is sketchy. Examples are transducers, photometric instrumentation, and automatic control.

Over 70 important topics are included, and each has been covered by experts. Theory is carefully included, along with complete definitions and examples. Charts and graphs provide directly useful information, and where data are too complex for brief treatment, extensive bibliographies are offered.

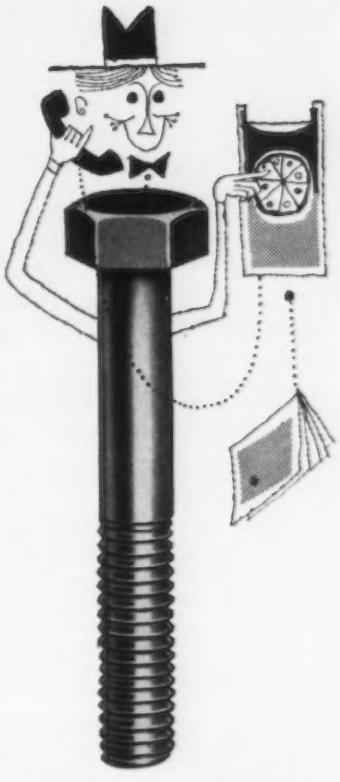
Some areas covered are temperature, pressure, flow, level, chemical composition, speed, humidity, viscosity, recorders, controllers, final-control elements, and even a section on the theory of automatic control. Although extreme detail and high-powered math are avoided, a good working knowledge of the broad field of control can be obtained.

Glass-Reinforced Plastics, 2nd Edition

Edited by Phillip Morgan, *Editor of "British Plastics" Published by Philosophical Library, 15 E. 40th St., New York 16.* 6¼x10, 276 pp. $15.

First published in 1954, this book covers all phases of reinforced plastics—from chemistry to structural models in the design of large parts. All the basic resins are covered, with new information on recent developments in epoxies added in the new edition. The chapters are written by workers in the British plastics in-

(Continued on page 145)



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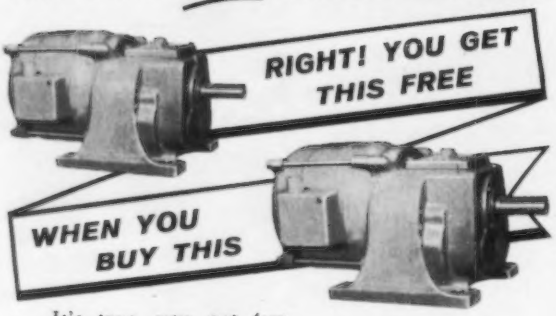

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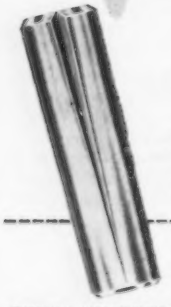

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dustry, each an expert in his area. The book has something of interest to anyone in the field—from neophyte designer to production man. Several chapters are devoted to commercial production methods, and several to applications in specific design fields—electrical, chemical, and aircraft, for example. The clearly written text is comprehensive, yet to the point, with the limitations of the material clearly stated in all phases of the study.

ASME Drafting Standards

Published by ASME, 29 W. 39th St., New York 18. 8½x11; Section 3, 11 pp., $1.50; Section 6, 18 pp., $1.50.

Section 3 (Projections) and 6 (Screw threads) of the planned six-section manual being compiled by ASME have been approved. Section 3 includes recommended practices in choice and arrangement of views, conventional breaks, intersections, developments, descriptive-geometry applications. Section 6 includes brief discussions of manufacturing processes, together with suggestions for thread representation, thread series and classes, selection, specification, dimensioning.

Letter Symbols for Heat and Thermodynamics

Published by ASME, 29 W. 39th St., New York 18. 8½x11; 14 pp., $1.50.

This is a revision of ASA Z10.4-1943. Listing of symbols is in tabular form, with information on other publications discussing each concept included.

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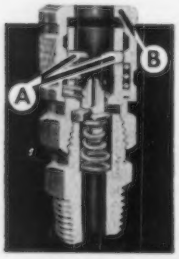

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While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Silicone Rubber Parts
Tips on curing methods, shape of parts and material selection for best service. Apr. 14, '58, p. 69. Circle No. E20

Pressure Drops in Air Valves
Technique estimates pressure losses in a pneumatic system, component by component. Charts give K-factors for actual valves and fittings. Apr. 14, '58, p. 74. Circle No. E 19

Plastics for Abrasion Resistance
Table lists specific properties of elastomers and rigid plastics that resist abrasion best. Mar 31, '58, p. 105. Circle No. E 18

Instrument Bearings for 300 F and Up
What happens to ball bearings operated above 300 F; special materials and lubricants that give better performance. Feb. 3, '58, p. 72. Circle No. E 17

Textured Steel
Types available; when, where and how to use it; two new processes. Mar. 17, '58, p. 73. Circle No. E 15

Which Adhesives for What
How to apply them and to what metals; with data tabulated for fast reference. Mar. 17, '58, p. 79. Circle No. E 14

Exotic Metals
Design data on nine "rare" metals with valuable though tantalizing properties. Mar. 17, '58, p. 66. Circle No. E 13

7 Ways to Start High-Inertia Loads
Large table analyzes relative performance of each basic method, as an aid in matching a specific load condition. Mar. 3, '58, p. 75. Circle No. E 12

Which Way to Make a Cam
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(Continued on page 149)

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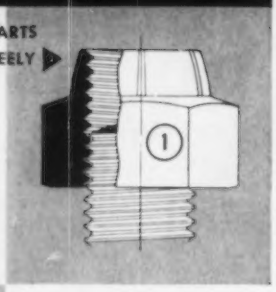
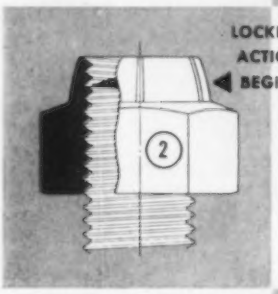
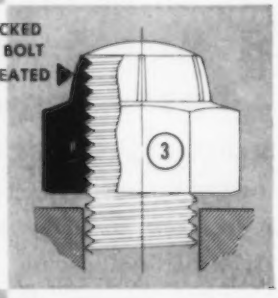
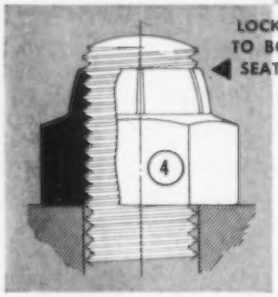




friction lock, between the load carrying flanks of the nut and the bolt threads. The combined metal to metal hugging and locking friction is distributed over all of the threads, enabling "HUGLOCK" to grip the bolt firmly, until removed by a wrench . . . The one-piece all metal construction and the continuous thread, extending through the length of the nut, provide maximum thread shear strength. The "HUGLOCK" principle can be incorporated into nuts of standard size, with standard threads or special sizes with special threads . . . "HUGLOCK" maintains its locking action, through repeated removals or re-use on the same bolt or a similar bolt of commercial thread tolerance. It locks to the bolt, whether the nut is seated or unseated. "HUGLOCK" eliminates axial thread play which tends to make a nut creep from its seat and work loose, under severe vibration or shock . . . All lock washers, cotter pins, key plates and other locking devices can be eliminated . . . The "HUGLOCK" section of our catalog contains 24 pages. It includes complete information, specifications, engineering data, prices; will be furnished on request.





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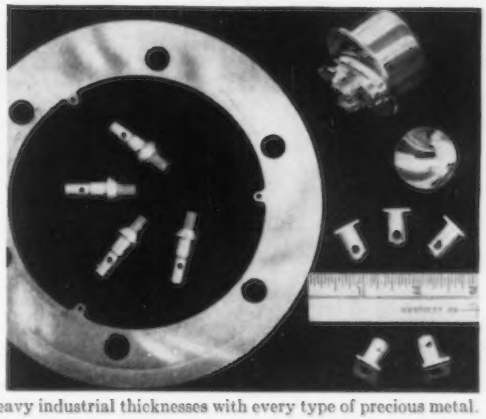

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INDEX OF PRODUCTS
ADVERTISED IN THIS ISSUE

After reading the advertisements classified below . . . MORE DETAILED INFORMATION about these products can be obtained by using the READER SERVICE CARD

A

Actuators
Mechanical 13
Aluminum Alloys 11
Aluminum Coated Sheet & Strip (see Steel, Coated)
Asbestos 132
Axles 142

B

Bars
Metal 11, 121
Bearings
Ball 32, 50, 91, 127, 149
Miniature 149
Needle 91
Roller 4, 32, 91, 149
Bellows 96
Belts, Timing 86
Belts, V 29-31
Bi-Metal 136
Brakes
Electric 136
Brushes 134

C

Cams 142
Capacitors 44-45
Carbon ..... 4th Cover
Carbon Parts 133
Casters 134
Castings 42, 152
Ceramics 105
Chemical Treatments 118, 122, 139
Chokes 44-45
Clad Metals 126
Clips, Electrical 137
Clutches
Electrical 136
Mechanical 147
Coatings 118, 122, 139
Coils 126
Connectors
Electrical 108
Controls
Electrical 15, 113
Electronic 15, 48
Hydraulic 109
Mechanical 144
Pneumatic 109
Cords 128-129
Couplings (see Connectors, Electrical)
Couplings
Hydraulic 146
Mechanical 8-9, 101
Cylinders
Hydraulic 109
Pneumatic 109

D

Decalcomanias 148
Die Castings 114, 145
Drafting
Machines 43
Drives
Right-Angle 132
Variable Speed 120

E

Engineering Services (see also Production Services) 134, 141
Extrusions
Nonmetallic 14, 105, 142

F

Fabricated Plastics (see Plastics, Fabricated)
Fastening Methods ... 16, 98, 106, 132, 143
Felt 119
Fibre 100
Filters
Air 138
Hydraulic 138
Flexible Shafts 135
Forgings 37
Friction Materials 29-31

G

Gaskets 14, 29-31
Gear Motors (see also Motor Reducers) 120, 144
Gears 101, 124
Glass 131
Graphite ..... 4th Cover

H

Handles & Knobs 134, 146
High Temperature Alloys 12

I

Instruments
Electrical 124-125

L

Lamps, Indicator 140
Laminated Plastics (see Plastics, Laminated)
Latches 16
Lubricants 118
Lubricating Equipment .. 2nd Cover, 6, 116

M

Metal Forming 137, 149
Metal, Pre-Finished 126
Moldings
Plastics (see Plastic Parts)
Powdered Metal (see Powdered Metal Parts)
Rubber (see Rubber Parts)
Molybdenum Alloys 27
Motor Reducers (see also Gear Motors) 10
Motors, A-C
Fractional 36, 40, 79-80, 107
Integral 40, 79-80, 107
Sub-Fractional ... 94, 104, 107, 124-125
Motors, D-C
Fractional 28, 36, 40, 79-80, 107
Integral 28, 40, 79-80, 107
Sub-Fractional 104, 107, 124-125

N

Name Plates 148
Nuts 137, 148

P

Packings 14, 29-31, 117, 115
Perforated Metals 94
Phosphor Bronze 93
Pillow Blocks 50
Pins 1, 98, 132, 144
Plastic Parts 136, 141, 142, 146
Plastics 17-18, 29-31, 142
Plastics Fabricated 136, 141
Plastics Laminated 100
Potentiometers 124-125
Powdered Metal Parts ..... 4th Cover 29-31, 34
Power Packs
Electrical & Electronic 148
Power Take-Offs 132, 147
Production Services (see also Engineering Services) 134
Pumps
Air 138
Liquid 35, 99, 110, 124-125, 138
Vacuum 138

R

Relays 44-45, 48, 84, 128-129
Reproduction Equipment 43
Resistors 44-45
Retaining Rings 95
Rheostats 44-45
Rivets 106
Rod Ends 32, 127
Rods
Nonmetallic 29-31, 100
Rubber 142
Rubber Parts ..... 3rd Cover, 29-31, 142
Rust Proofing 118

S

Screws 46, 137
Seals ... 3rd Cover, 14, 29-31, 41, 115, 145
Seating Work Equipment 140
Sheets
Metal 102, 126
Plastic 29-31, 100
Shims 112, 146
Solenoids 103
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.) 16, 46, 148
Speed Increasers & Reducers 120, 147
Splines 13
Springs 12
Stampings 137
Steel
Alloy 97
Coated 2, 33
Carbon 97
Stainless 102, 121
Strainers 138
Strip, Metallic 102, 126
Switches 38-39, 44-45, 81, 103

T

Terminals & Terminal Boards 108
Thermostats 96, 136, 143
Timers 146
Tools 108
Tracing Paper 144
Transformers 44-45
Transmissions 132
Tubing
Lock-Seam 111
Welded 2

V

Valves
Air 109
Hydraulic 109, 123, 137, 140
Solenoid 140

W

Welding
Equipment 88
Wire 121
Wire & Cable, Electric 128-129
Wire Cloth 137

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibilities for errors or omissions

A

AMP, Inc. 108
Acro Div., Robertshaw-Fulton Controls Co. 81
Adams & Westlake Co. 84
Allegheny Ludlum Steel Corp. 121
Allen Mfg. Co. 1
Allied Research Products, Inc. 139
Allis-Chalmers Mfg. Co. 28
Aluminum Co. of America 11, 143
American Brass Co. 93
American Felt Co. 119
American Insulator Corp. 141
American Lava Corp., Subs., Minnesota Mining & Mfg. Co. 105
American Nickeloid Co. 126
Amforge Div., American Brake Shoe Co. 37
Armco Steel Corp. 2
Armstrong Cork Co. 41
Automotive & Aircraft Div., American Chain & Cable Co. 144
Aviation Developments, Inc. 132

B

Bart Mfg. Corp. 149
Bethlehem Steel Co. 97
Borg Equipment Div., George W. Borg Corp. 124-125
Bruning Co., Inc., Charles 43
Bundy Tubing Co. 111

C

C. E. M. Co. 98
Century Electric Co. 40
Climax Molybdenum Co. 27
Cooper Alloy Corp. 152
Corning Glass Works 131
Cutler-Hammer, Inc. 48

D

De Laval Steam Turbine Co. 35
Diamond Mfg. Co. 94
Dimco-Gray Co. 146
Dodge Mfg. Corp. 8-9
Driv-Lok Sales Corp. 144
du Pont de Nemours & Co., (Inc.) E. I., Polychemicals Dept. 17-18

E

Eaton Mfg. Co., Foundry Div. 42
Essex Wire Corp., R B M Div. 128-129

F

Fairbanks, Morse & Co. 110
Farval Corp. ..... 2nd Cover
Flour City Brush Co. 134
Foster Mfg. Co., Inc. 146
Fostoria Pressed Steel Corp. 140
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. 96
Funk Mfg. Co. 132

G

Garlock Packing Co. 14
Gear Motor Co. 144
General Electric Co., Apparatus Dept. 148
General Industries Co. 94
Gits Bros. Mfg. Co. 6
Gleason Works 101
Gries Reproducer Corp. 145

H

Heim Co. 32
Heinze Electric Co. 104
Houghton & Co., E. F. 117
Howard Industries, Inc. 107
Hyatt Bearings Div., General Motors Corp. 4

I

Imperial Tracing Cloth 144
Industrial Products Suppliers 146

J

Jarvis & Jarvis, Inc. 134
Jergens Tool Specialty Co. 134
Johns-Manville Corp. 115
Johnson Rubber Co. 142

K

Kalamazoo Div., The New York Airbrake Co. 99
Kaydon Engineering Corp. 91
Kraissl Co. 138

L

Laminated Shim Co., Inc. 112
Landis & Gyr, Inc. 149
Lincoln Electric Co. 88
Logansport Machine Co., Inc. 109

M

McLouth Steel Corp. 102
Magnatrol Valve Corp. 140
Metalart Corp. 137
Metal & Thermit Corp. 122
Meyercord Co., Name Plate Div. 148
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 38-39
Milsco Mfg. Co. 140
Minneapolis-Honeywell Regulator Co. 113
Minnesota Rubber Co. ..... 3rd Cover
Moraine Products Div., General Motors Corp. 34
Morganite, Inc. 133
Mt. Vernon Die Casting Corp. 114

N

National Acme Co., Electric Mfg. Div. 103
National Machine Products Co. 148
National-Standard Co. 12
New Departure Div., General Motors Corp. 50
New-York Airbrake Co., The, Kalamazoo Div. 99
Norgren Co., C. A. 116
North American Asbestos Corp. 132

O

Ohmite Mfg. Co. 44-45

P

Packard Electric Div., General Motors Corp. 36
Parker Rust Proof Co. 118
Perfection Gear Co., American Stock Gear Div. 124
Philadelphia Gear Works, Inc. 10
Powers Regulator Co., The 143
Prior Products, Inc. 142
Proctor Electric Co., Equipment Div. 136

R

Raybestos-Manhattan, Inc., Manhattan Rubber Div. 30-31
Raybestos-Manhatan, Inc. Packing Div. 29
Rhodes, Inc., M. H. 146
Rockford Clutch Div., Borg-Warner Corp. 147
Rockwood Sprinkler Co., Ball Valve Div. 123
Rowbottom Machine Co. 142
Russell, Burdsall & Ward Bolt & Nut Co. 46

S

Saginaw Steering Gear Div., General Motors Corp. 13
Simplatrol Products Corp. 136
Sinko Mfg. & Tool Co. 136
South Chester Corp., Southco Div. 16
Square D Co. 15
Stephens-Adamson Mfg. Co., Sealmaster Bearing Div. 127
Sterling Electric Motors, Inc. 120
Stow Mfg. Co. 135
Stratoflo Products, Inc. 137

T

Taylor Fibre Co. 100
Thomson Mfg. Co., Judson L. 106

U

United Metallic "O" Ring Corp., Div., United Aircraft Products, Inc. 145
U. S. Graphite Co., Div. of the Wickes Corp. ..... 4th Cover
U. S. Rubber Co., Mechanical Goods Div. 86

V

Viking Pump Co. 125

W

Wagner Electric Corp. 79-80
Waldes Kohinoor, Inc. 95
Weckesser Co. 137
Weirton Steel Co., Div., National Steel Corp. 33

PRODUCT ENGINEERING ADVERTISING SALES STAFF

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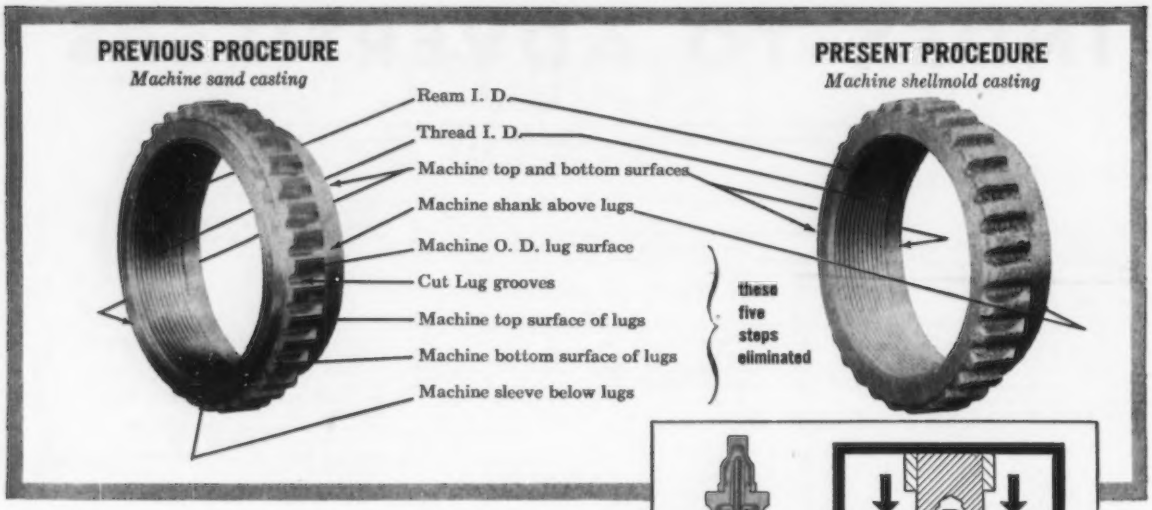
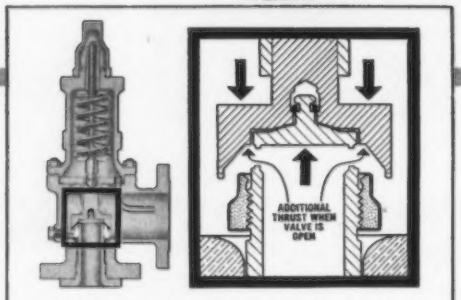
Index to Advertisers begins on P. 151
Products Index begins on P. 150





The adjusting ring is an important regulatory element in Consolidated Safety and Relief Valves and Consolidated Safety Relief Valves, made by Manning, Maxwell & Moore, Inc., in Stratford, Connecticut, and Tulsa, Oklahoma, respectively. Because the safety relief valves are installed to provide protection of many different types of pressure vessels and fluid lines, handling many types of fluids under a variety of pressure and temperature conditions, the adjusting ring serves a very important function in the control of the fluid forces. In combination with the precise contours of the other fluid deflecting means, complete control of the fluid forces is attained. Stainless steel adjusting rings are predominantly used for reasons of resistance to oxidation and erosion.

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How to cut costs, improve design with close-tolerance stainless castings

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1. The lugs were designed to be *cast in entirety*, with no subsequent machining of their surfaces at all.
2. The lugs were made narrower, and their number increased, to make possible greater accuracy of adjustment with the finger tool.
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E15. Textured Steel
New processes, texturing methods, design data and trends

E17. Bearings for 300F and Up
Special materials and lubricants that give better performance for instrument bearings

E18. Plastics for Abrasion Resistance
Properties tabulated for wear resisting elastometers and rigid plastics

E19. K Factors
Charts give K-factors for actual valves and fittings

E20. Silicone Rubber Parts
Tips on curing methods, shape of parts and other variables that determine satisfactory service.

NEW COMPONENTS,

DESCRIPTION OF THESE NEW ENGINEERING

GENERAL ENGINEERING
40—Angled Pen Nib Set
37—Bearing Tester

METALS AND ALLOYS
23—Multi-design Expanded Metals

NON-METALLIC MATERIALS, FINISHES
3—High-temperature Rubber
35—Hard Acrylic Enamels

REPRINTS OF EDITORIAL FEATURES

E1 E5 E7 E10 E12 E13 E14 E15 E17 E18 E19 E20

MORE INFORMATION ABOUT PRODUCTS ADVERTISED

C2	1	2	4	6	8-9	10	11	12	13	14	15	16
17-8	27	28	29	30	L31	R31	32	33	34	35	37	38-9
40	41	42	43	44-5	46	48	50	79-80	81	84	86	88
91	93	L94	R94	95	96	97	98	99	100	101	102	103
104	105	106	107	108	109	110	111	112	114	115	116	117
118	119	120	121	122	123	L124	R124	L125	R125	126	127	128-9
130	131	L132	TR132	BR132	133	T134	BL134	BR134	135	L136	TR136	BR136
TL137	BL137	R137	138	139	L140	TR140	BR140	141	T142	BL142	BR142	L143
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TR148	BR148	T149	B149	152	C3	C4						

MORE DATA ABOUT COMPONENTS AND MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40												

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91	93	L94	R94	95	96	97	98	99	100	101	102	103
104	105	106	107	108	109	110	111	112	114	115	116	117
118	119	120	121	122	123	L124	R124	L125	R125	126	127	128-9
130	131	L132	TR132	BR132	133	T134	BL134	BR134	135	L136	TR136	BR136
TL137	BL137	R137	138	139	L140	TR140	BR140	141	T142	BL142	BR142	L143
R143	TL144	TR144	BL144	BR144	T145	B145	TL146	TR146	BL146	BR146	147	L148
TR148	BR148	T149	B149	152	C3	C4						

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NEW CATALOGS

DESCRIBED ON PAGES 129-137

GENERAL ENGINEERING
60—Engineering Dept. Equipment

METAL AND ALLOYS
49—Platinum Products
65—Magnetic and Electrical Alloys
58—Aluminized Steel

NON-METALLIC MATERIALS, FINISHES
54—Tooling Plastics
63—Nickel-Phosphide Coating
48—Special-property Plastics

FABRICATION PROCESSES AND PRODUCTION
67—Semi-pneumatic and Solid Tires
56—Coating Chemicals for Aluminum
64—Sonic Sifting

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EMS APPEAR ON PAGES 89-125. CIRCLE KEY NUMBER FOR ADDITIONAL INFORMATION.

FABRICATION PROCESSES AND PRODUCTION
21—Self-contained Mist Coolant
25—Welding of Terminals

POWER TRANSMISSION
38—Adjustable Speed Drive

MECHANICAL PARTS
4—Solenoid-operated Lubricator
9—Self-tapping Insert
28—Recoil Tubing

FASTENING AND JOINING
15—Disk Couplings
14—Weld Screw Has Rim
18—Interchangeable Couplings
26—Flexible Nylon Coupling

MOTORS, ENGINES AND CONTROLS
1—Photoelectric Counter
2—Pneumatic Web Control
5—Electronic Counting Package
12—Hollow-shaft Motor Reducer
8—Combination Flow Regulator
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57—Stationary Tachometers

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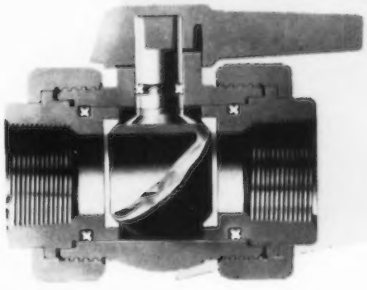

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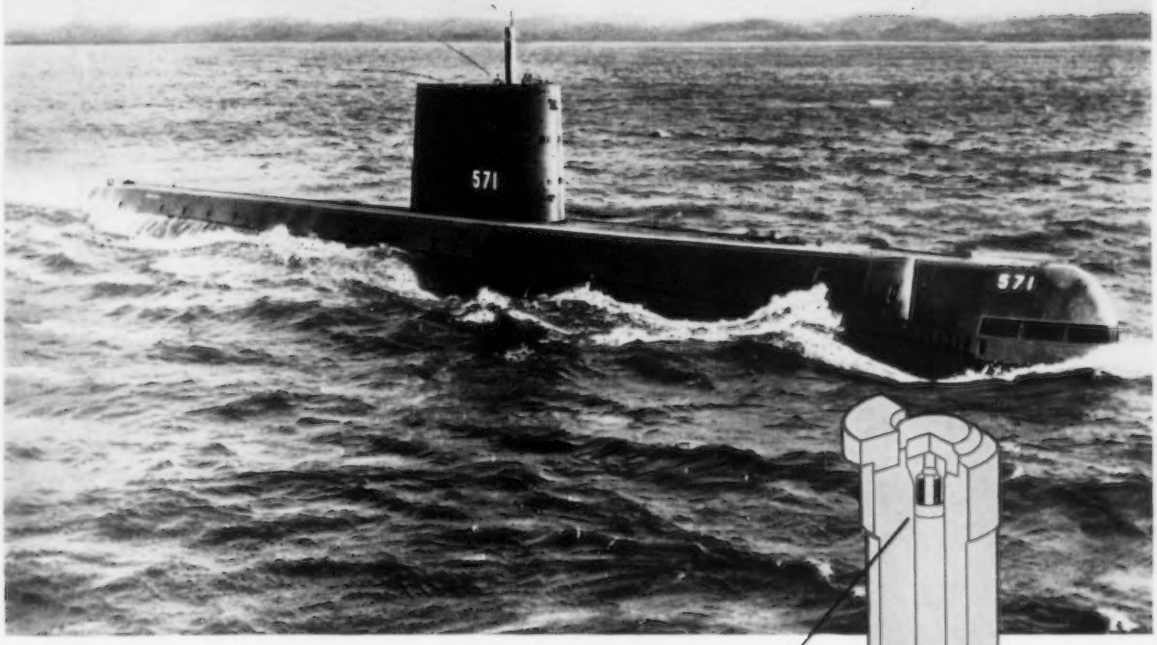

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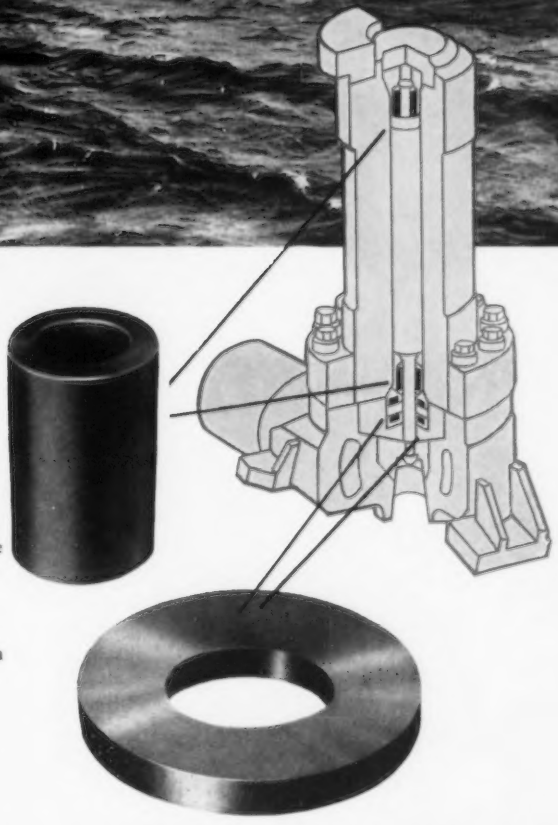

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